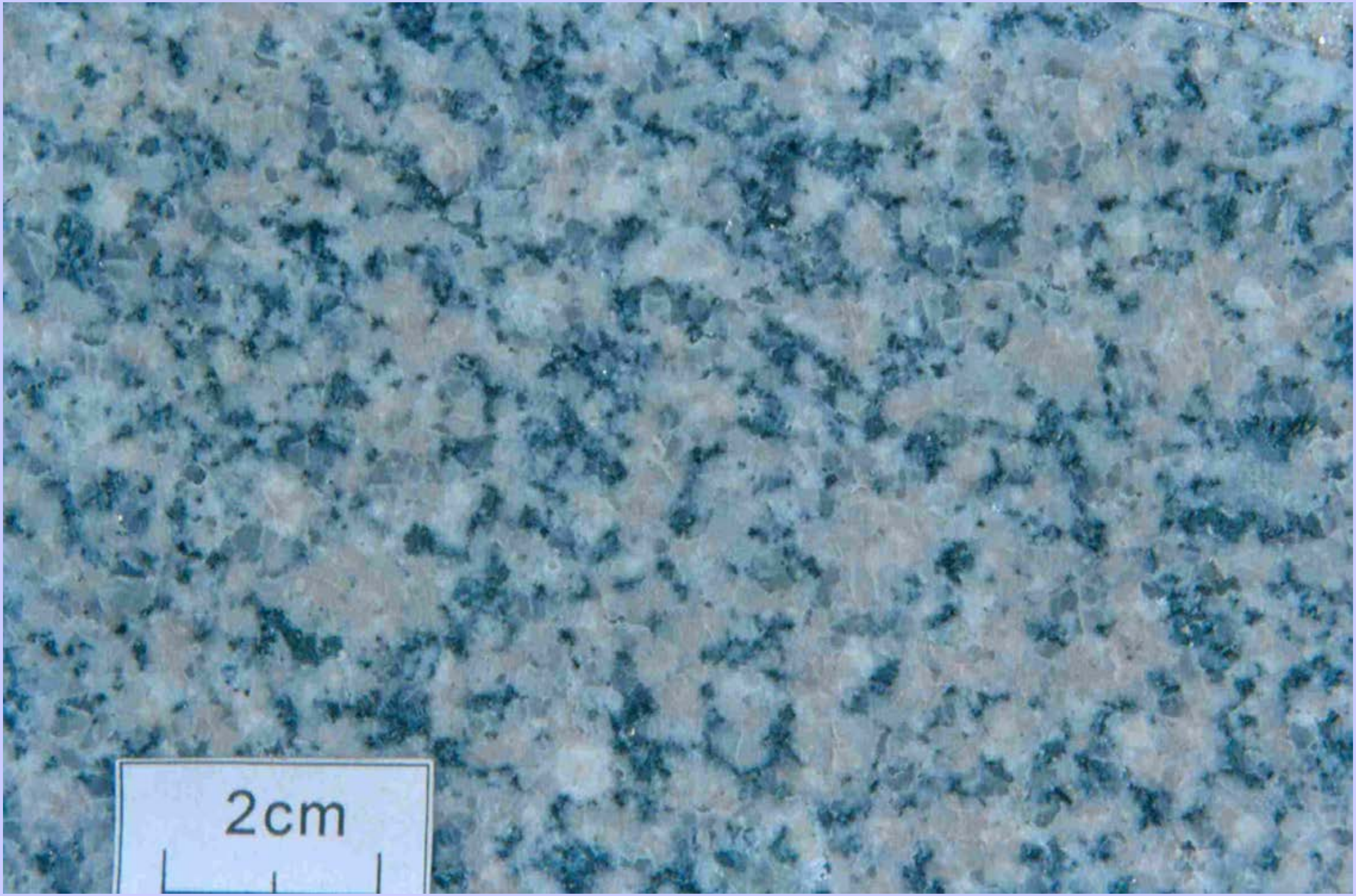
Estruturas das rochas ígneas

ESTRUTURAS: relações entre as diferentes porções de uma rocha

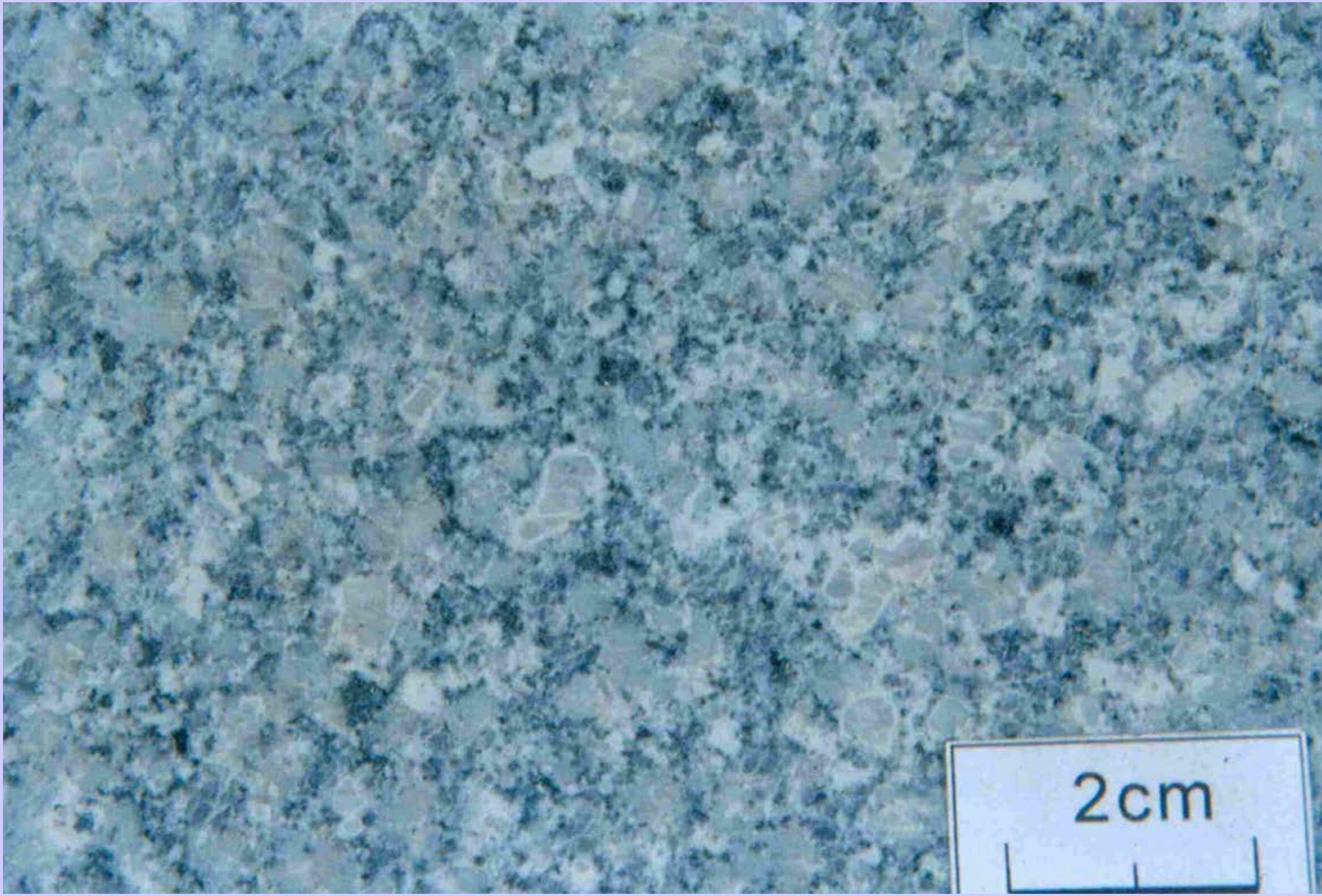
Na escala **mesoscópica** (de afloramento):

- estrutura maciça
- foliação magmática ou de estado sólido
- venulações
- bandamento magmático
- enclaves, xenólitos

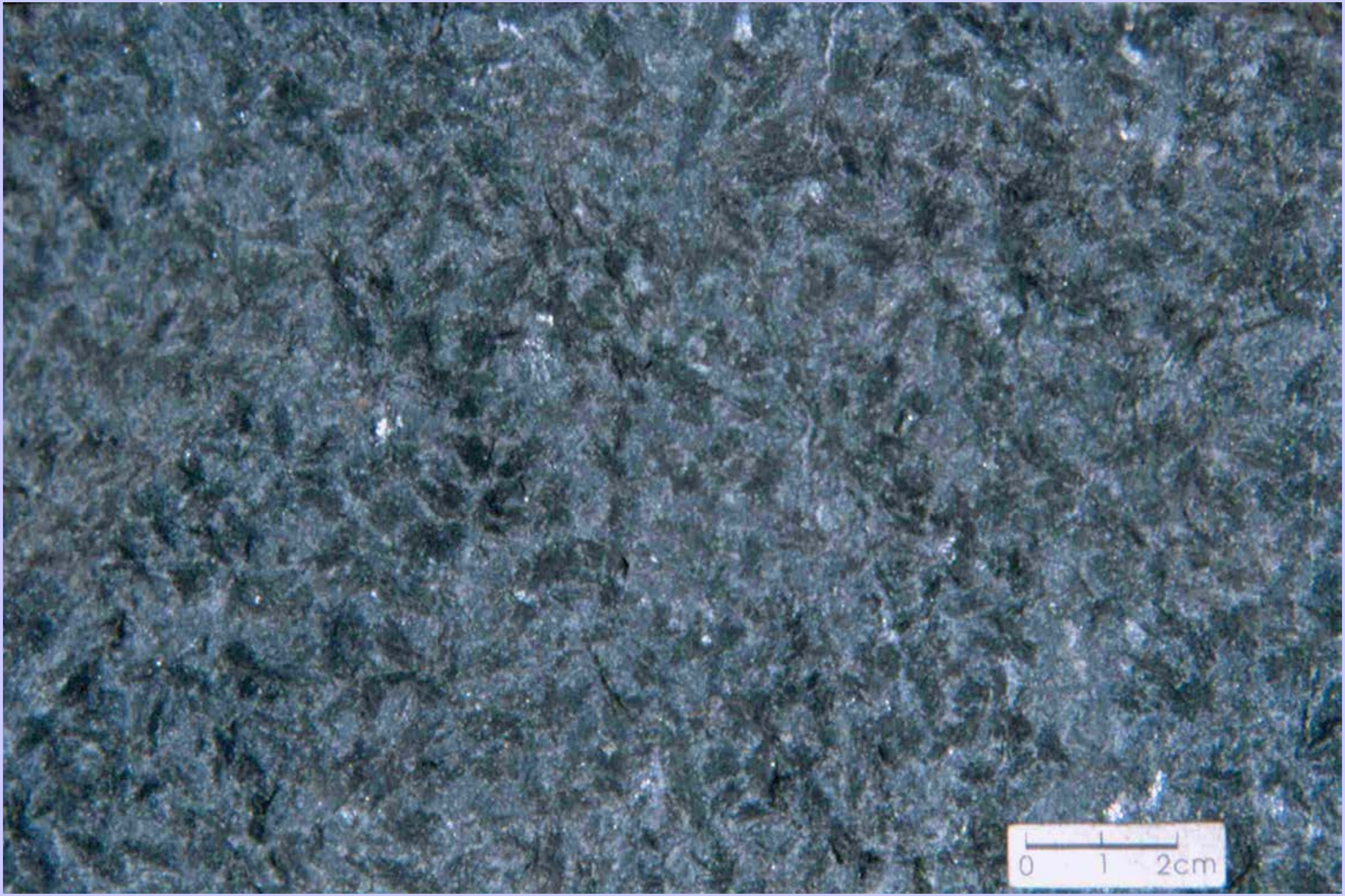
Na escala **macroscópica** (regional):
* geometria, dimensões, atitudes, relações de contato de um corpo rochoso;
* agrupamento de corpos ígneos (maciços, suites, províncias)



granito equigranular maciço

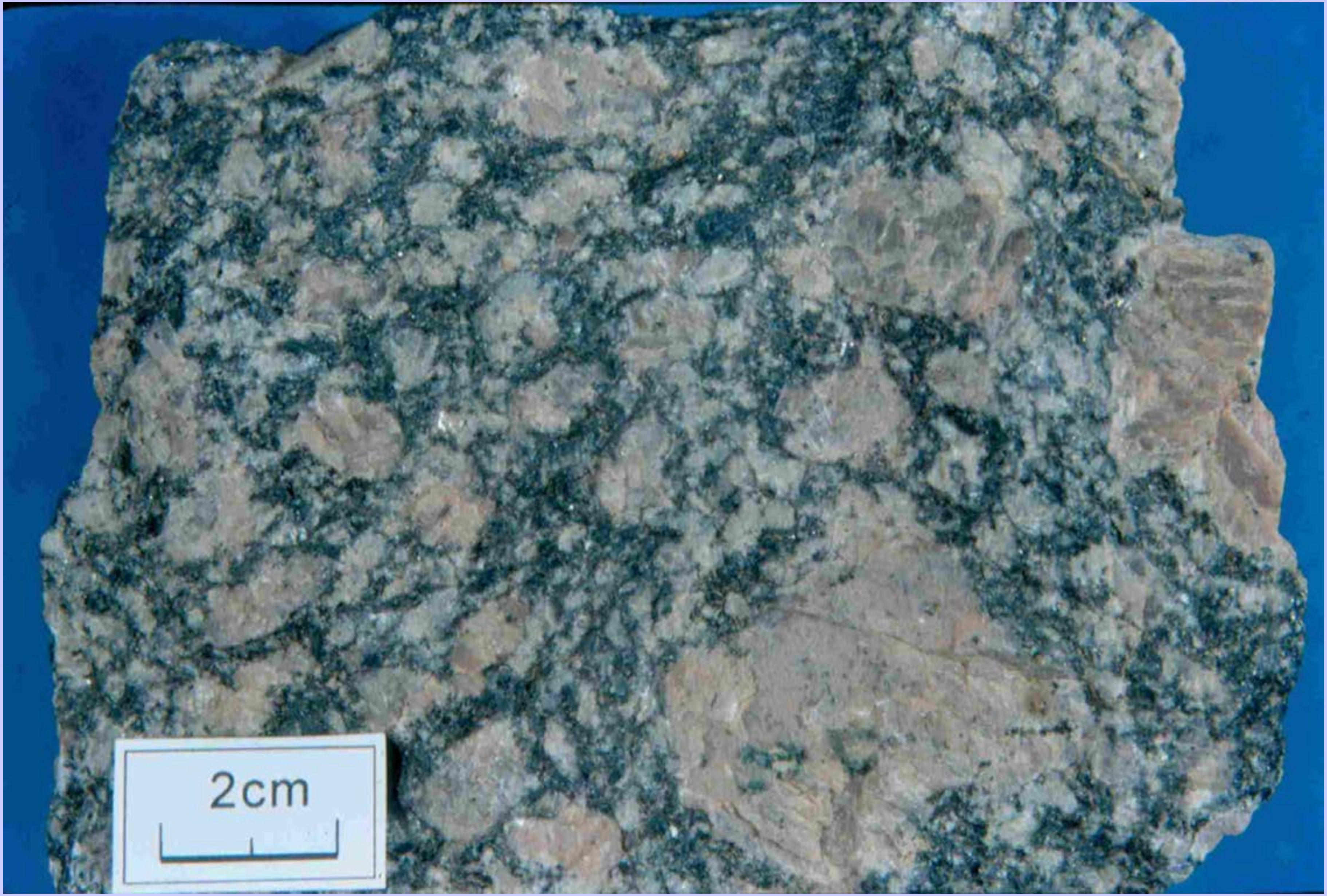


granito inequigranular



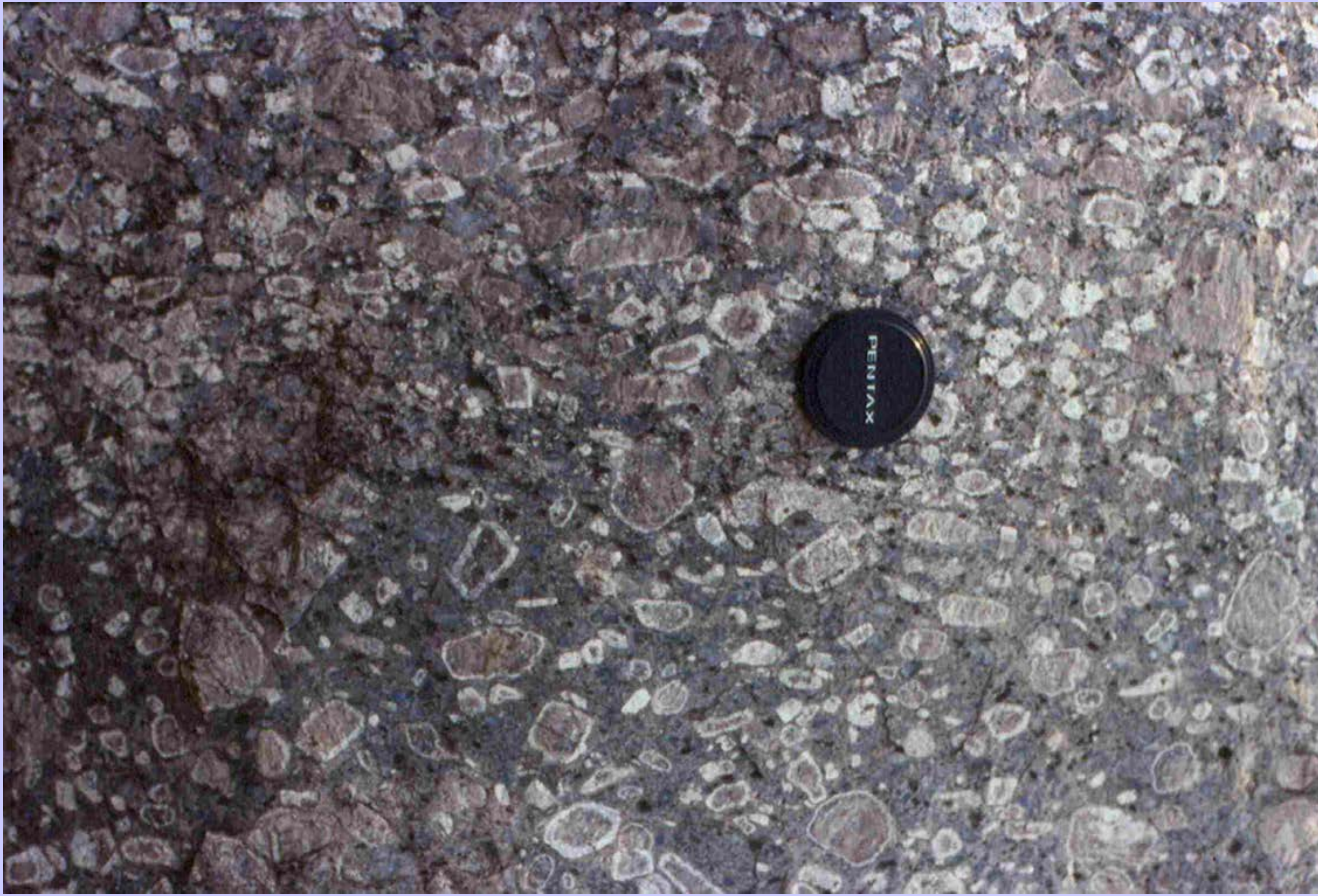
gabro equigranular maciço

gabro cumulático (Ilhabela, SP)



granito porfirítico

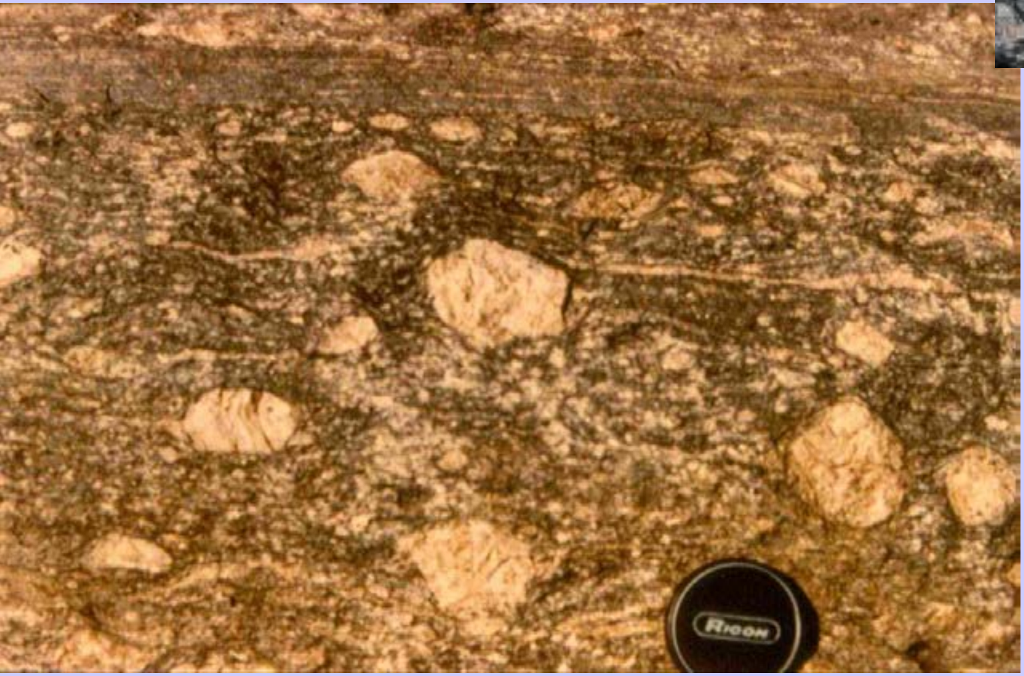
granito rapakivi; Serra da Providência, Rondônia



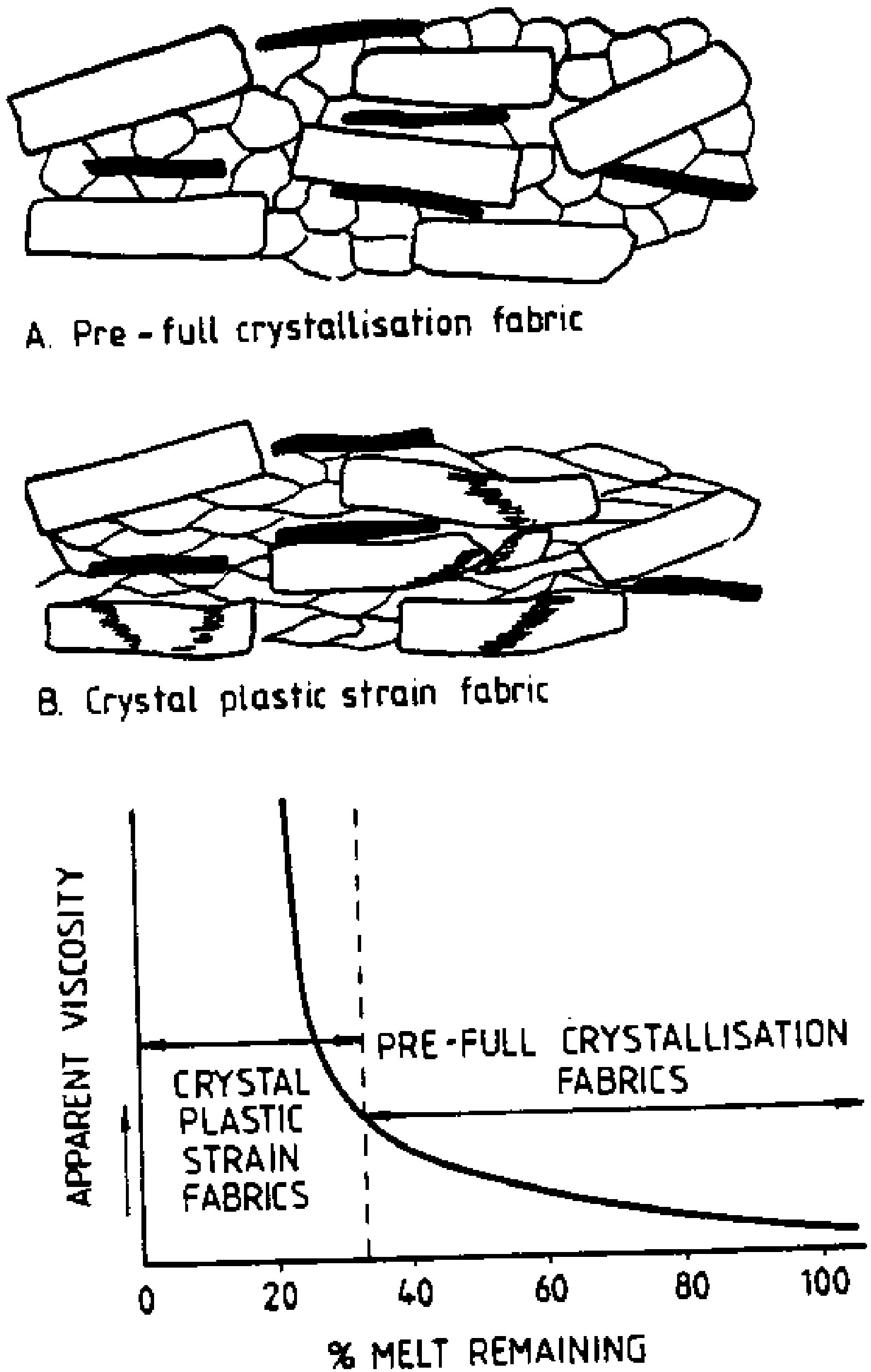
granito rapakivi; Serra da Providência, Rondônia

granito rapakivi; Serra da Providência, Rondônia

Foliação de fluxo magmático (granito Mauá, SP)



Foliação de estado sólido (campus da USP, SP)

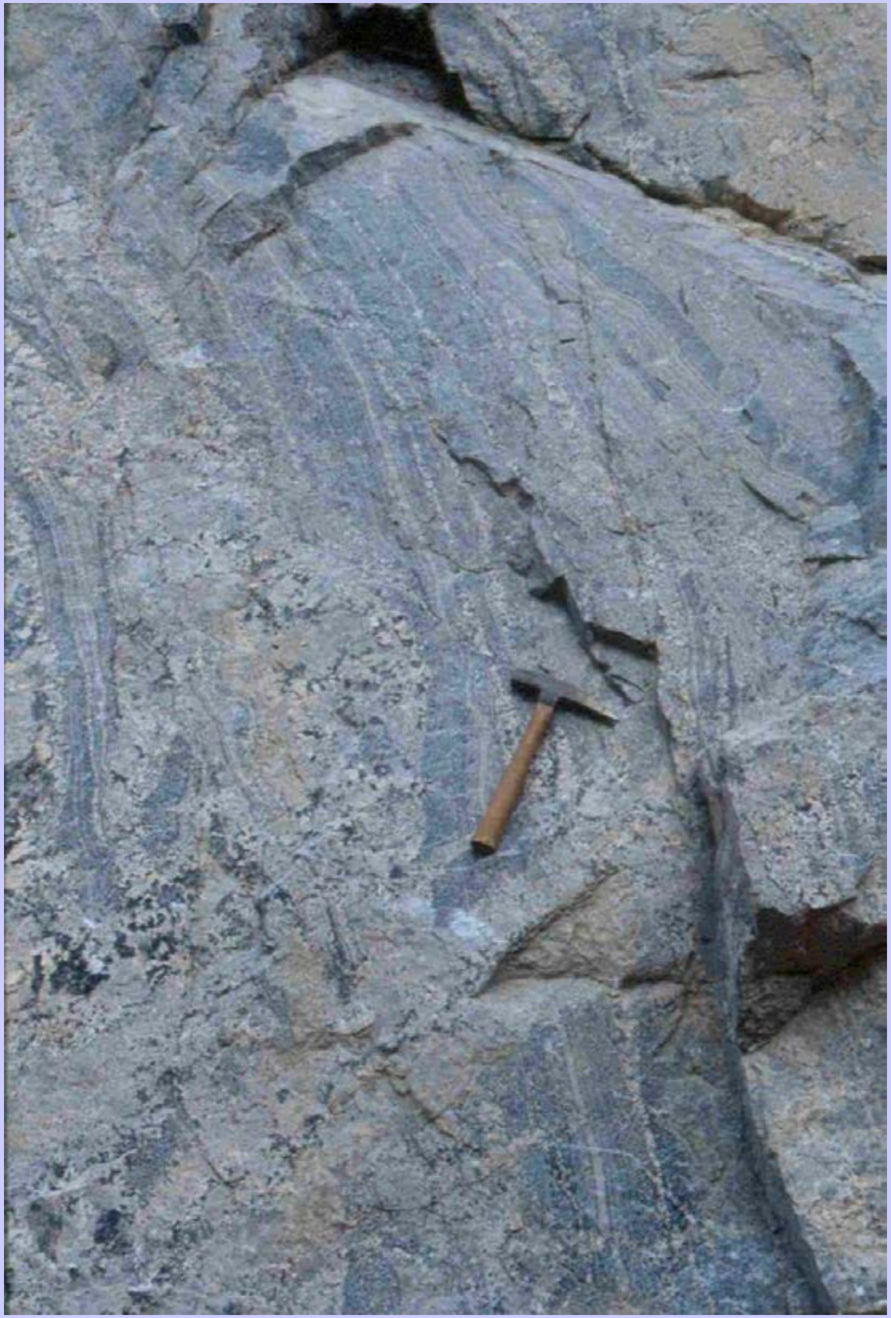


Desenvolvimento de trama orientada (“fabric”) em rochas plutônicas:

“foliação magmática”
(pré-cristalização total)
e
“foliação de estado sólido”
(“crystal-plastic strain”)

Venulações

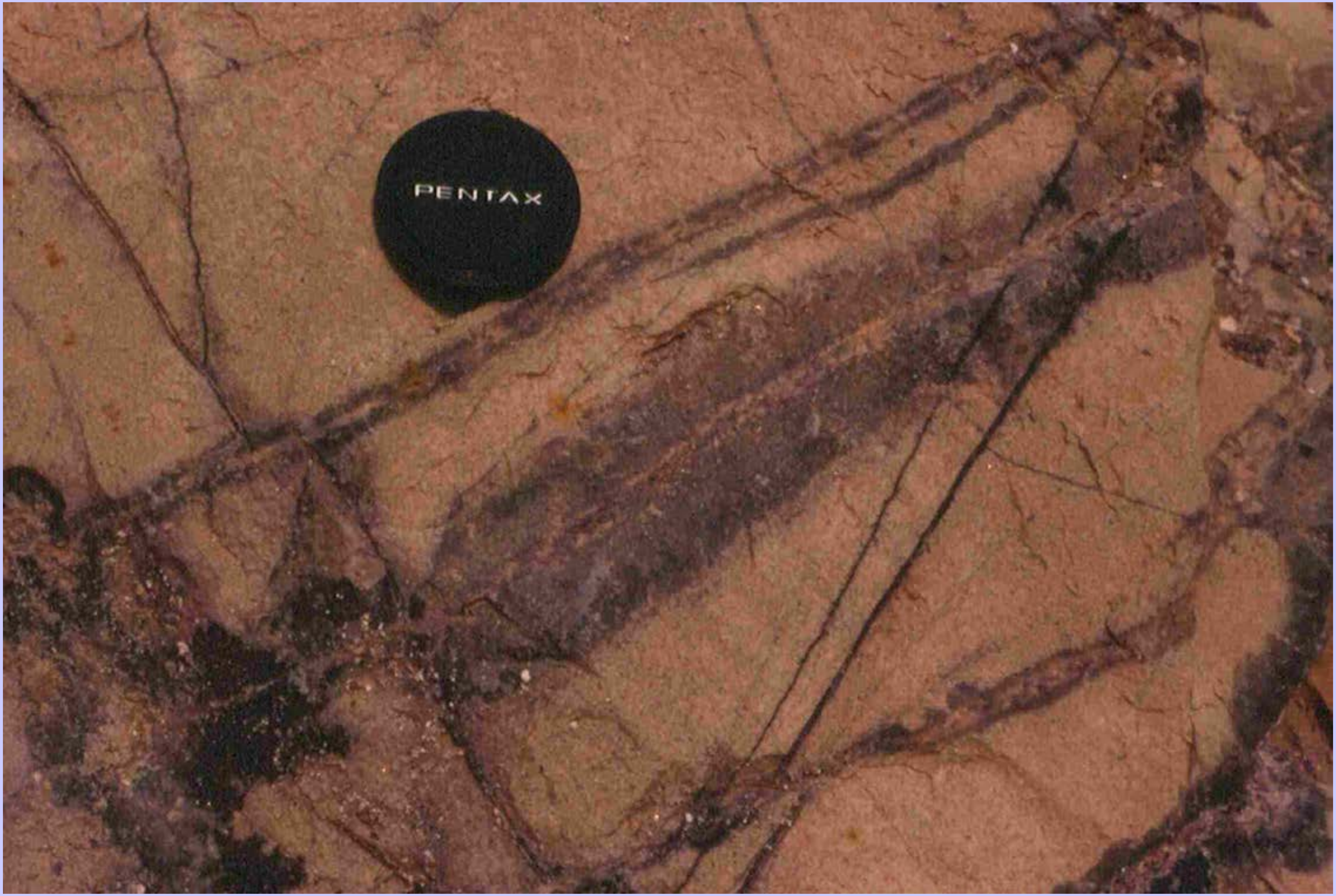
Veio de aplito, Mauá, SP



pegmatito com turmalina aplito bandado, Perus

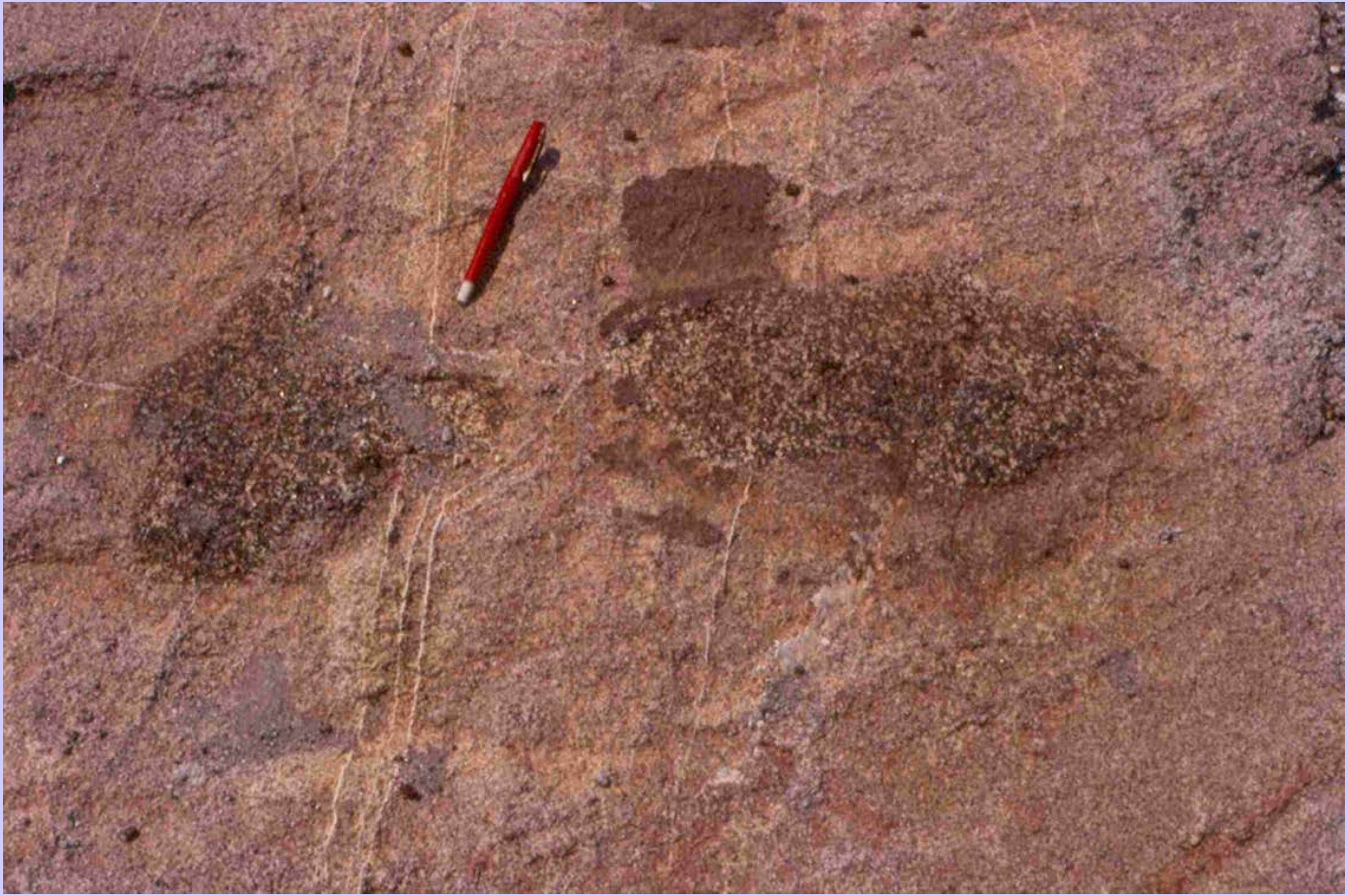
pegmatito com cavidade miarolítica

pegmatito com cavidade miarolítica



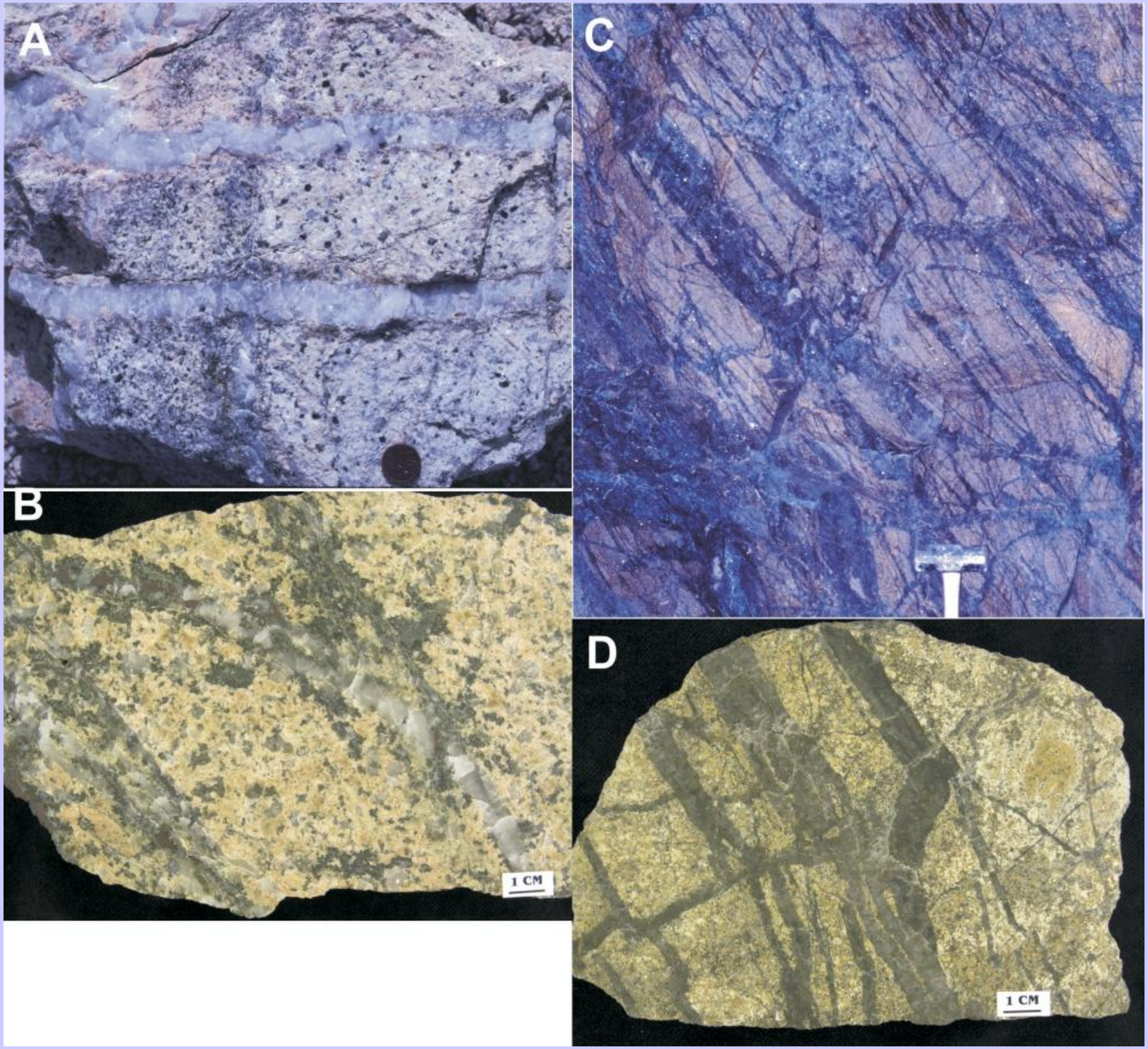
greisen em fratura de riolito; Bom Futuro, Rondônia

greisen em bolas, Rondônia



greisen em bolas, Rondônia

veio de qtz com molibdenita; Santo Amaro, Rondônia



A- Potassic (K-feldspar) alteration around chalcopyrite- and bornite-bearing quartz veins. Valley deposit, Highland Valley district, British Columbia;

B-bornite-bearing quartz veins cutting Bethsaida granodiorite that is pervasively and potassically altered to K-feldspar. Valley deposit, Highland Valley district, British Columbia (KQ-82-50B);

C-fine-grained granite cut by wolframite- and molybdenite-bearing fracture stockwork with biotitic alteration selvages;

D- Quartz-pyrite-chalcopyrite vein stockworks in feldspar porphyry heavily overprinted by sericitic (phyllic) alteration. Bell deposit, Babine district, British Columbia (KQ-82-71).

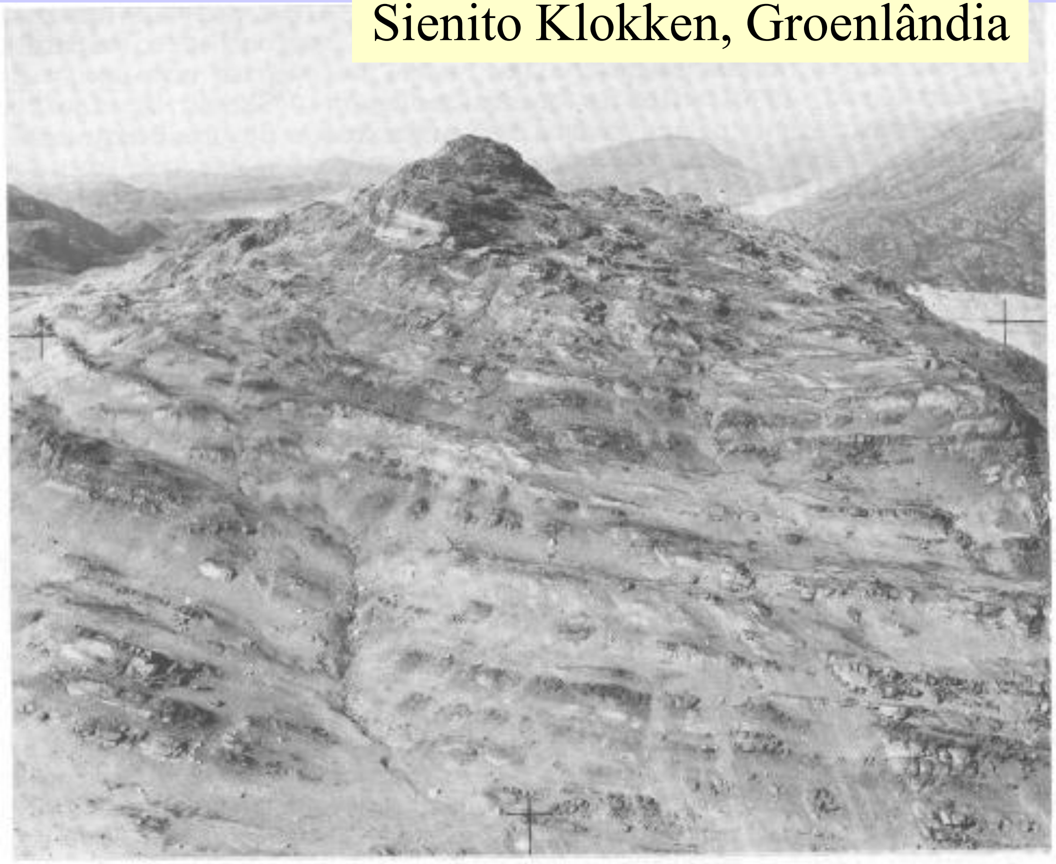
Bandamento magmático

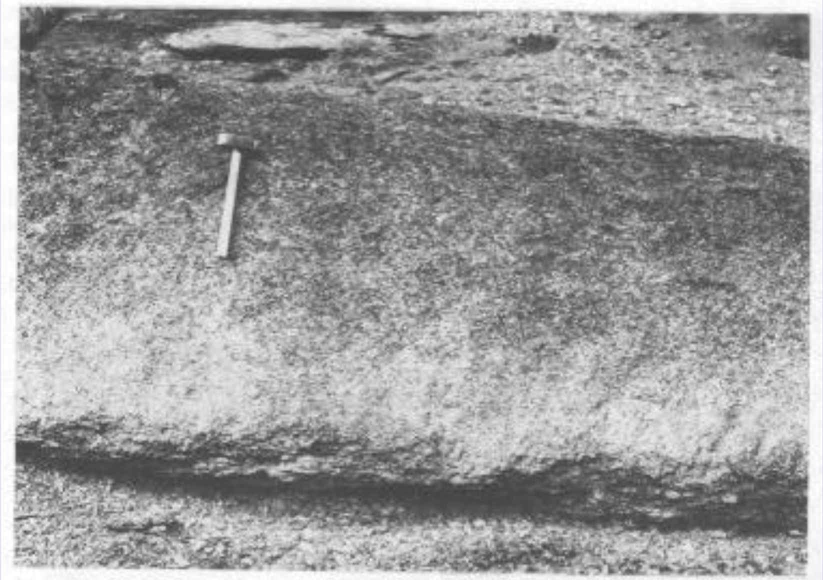
Feições de sedimentação em câmaras magmáticas

gabro bandado, Ilhabela, SP

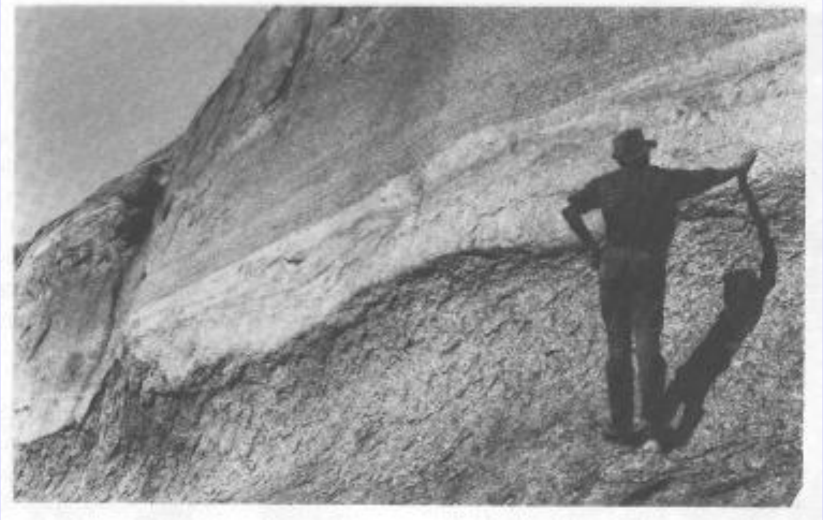
sienito com bandamento modal, Caldas, MG

Sienito Klokken, Groenlândia





(a)



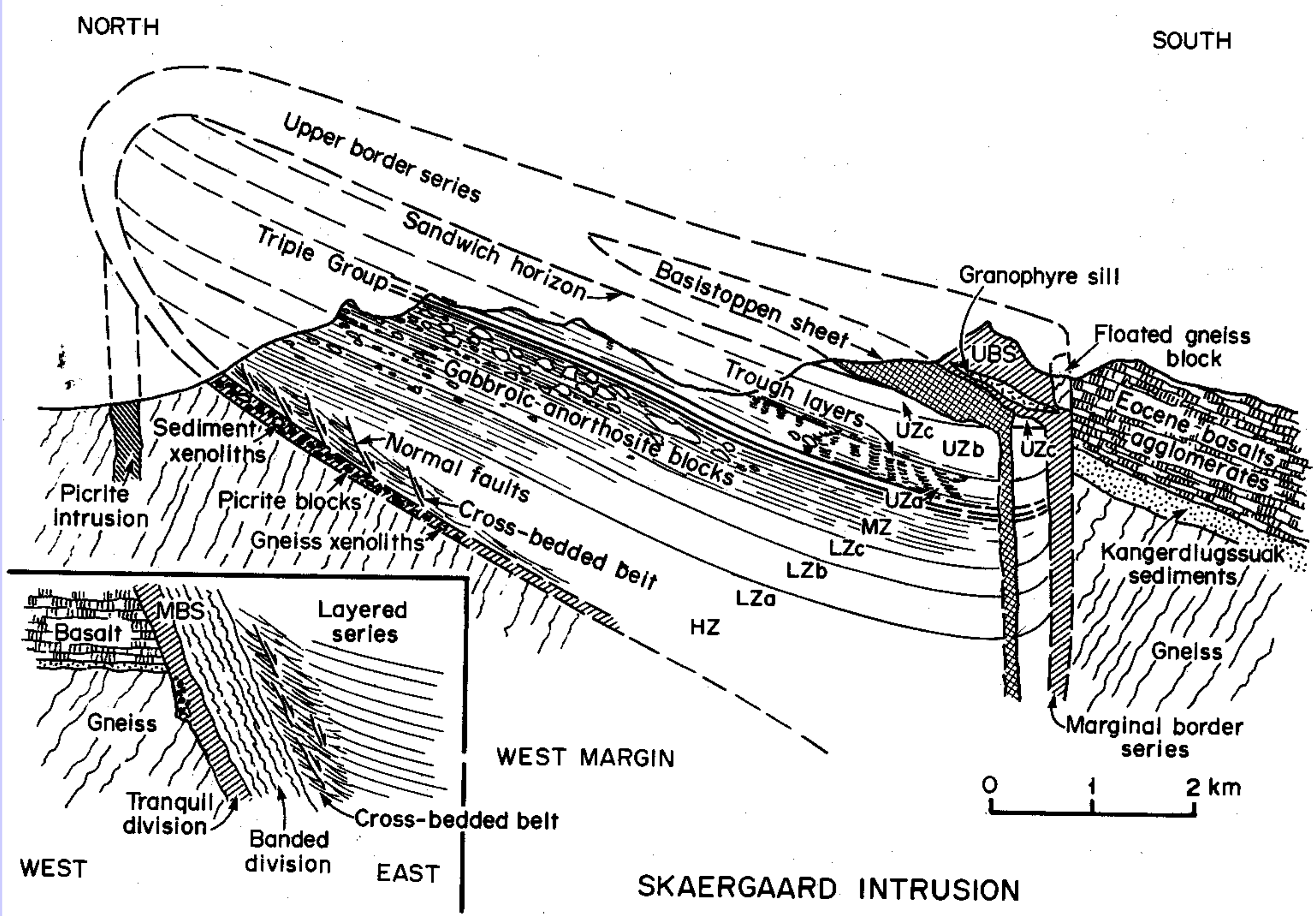


Figure 16. Semidiagramatic cross sections of the Skaergaard intrusion showing its principal features.

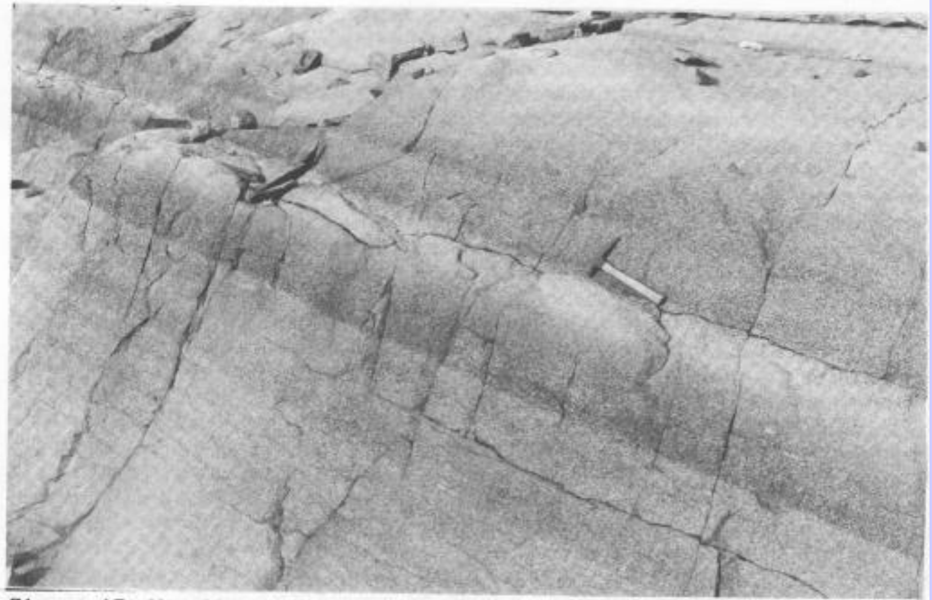


Figure 17. Modally graded layer in Skaergaard MZ gabbro, lower west flank of Pukugaqryggen. The layer is one of the thickest of its type.

Figure 18. Modally graded layers alternating with uniform layers in UZa, near North House site. Note the strongly bipartite nature of the layers.

Figure 19. Diffuse modally graded layers in UZa.

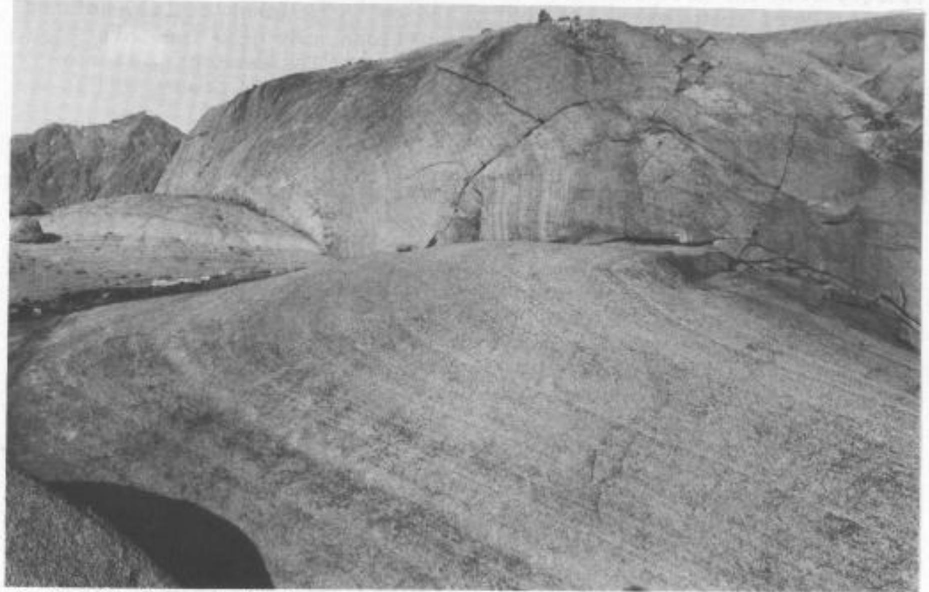


Figure 20. Microrhythmic layering extending through a subsidiary trough and over an intratrough ridge in UZa. The layers have almost constant thickness, so they do not become planar upsection (contrast Fig. 7).

Bandamento modal, Skaergaard

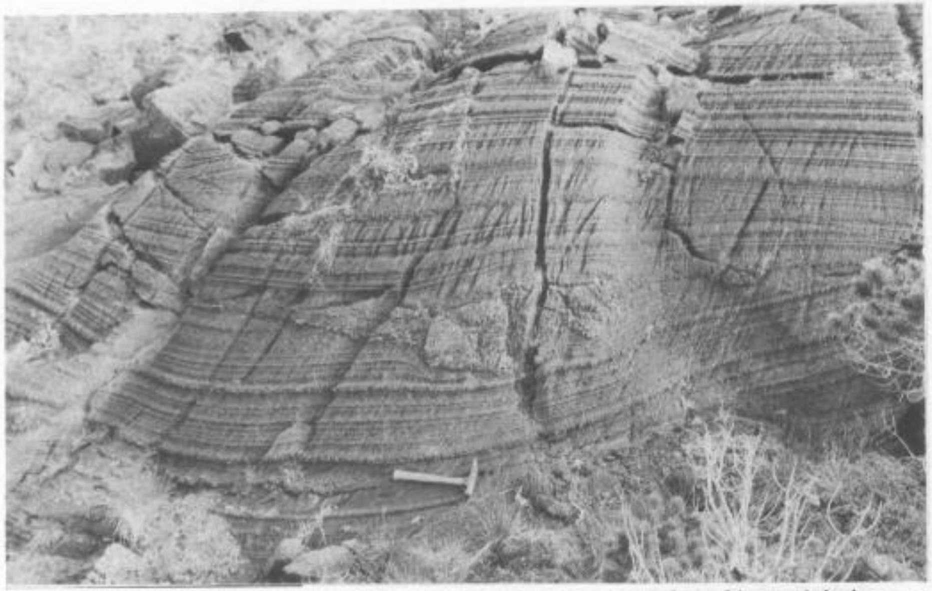


Figure 6. A 1-metre olivine clinopyroxenite block plus finer debris along an unconformity in layered peridotite. (Locality 5, Fig. 4).

Figure 7. Layering in olivine-rich clinopyroxenite draped over a large block of older olivine clinopyroxenite. The layers thin over the block, so by the top of the outcrop, they are almost planar.

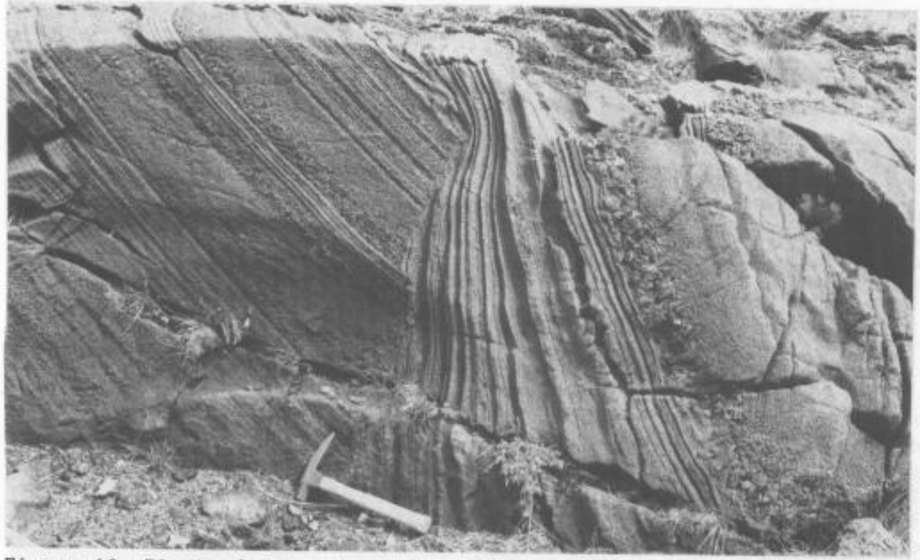


Figure 10. Block of layered olivine clinopyroxenite draped by layers of similar composition, just outside the northeast edge of the younger intrusion.

Figure 11. A quartz xenolith in layered olivine-rich pyroxenite. About a dozen of these xenoliths in the Hall Cove younger intrusion are the only foreign rocks in the Duke Island ultramafic complex.

Feições de bandamento e xenólitos, Duke Island, Alaska

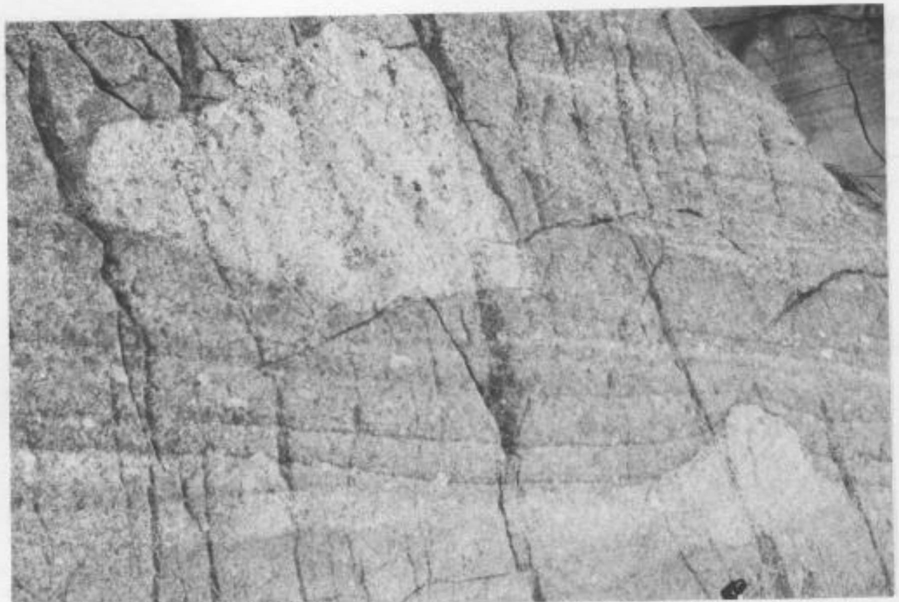
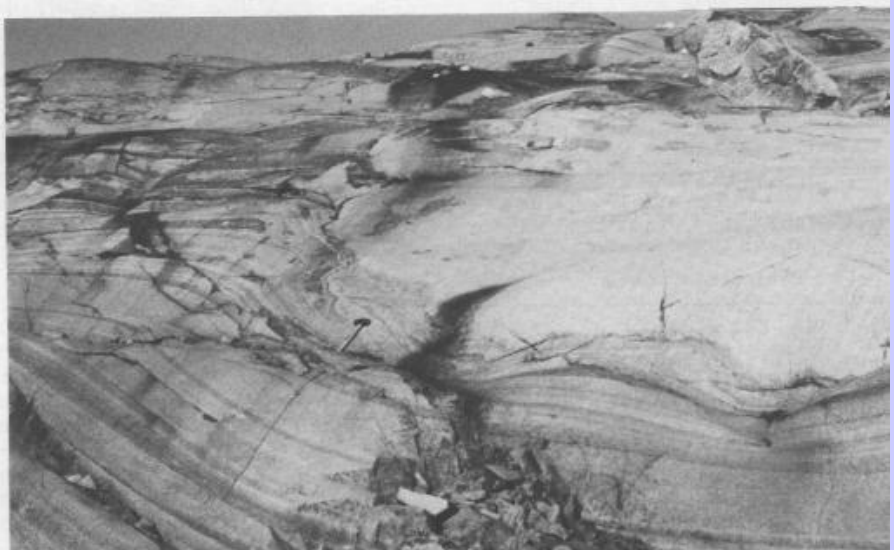


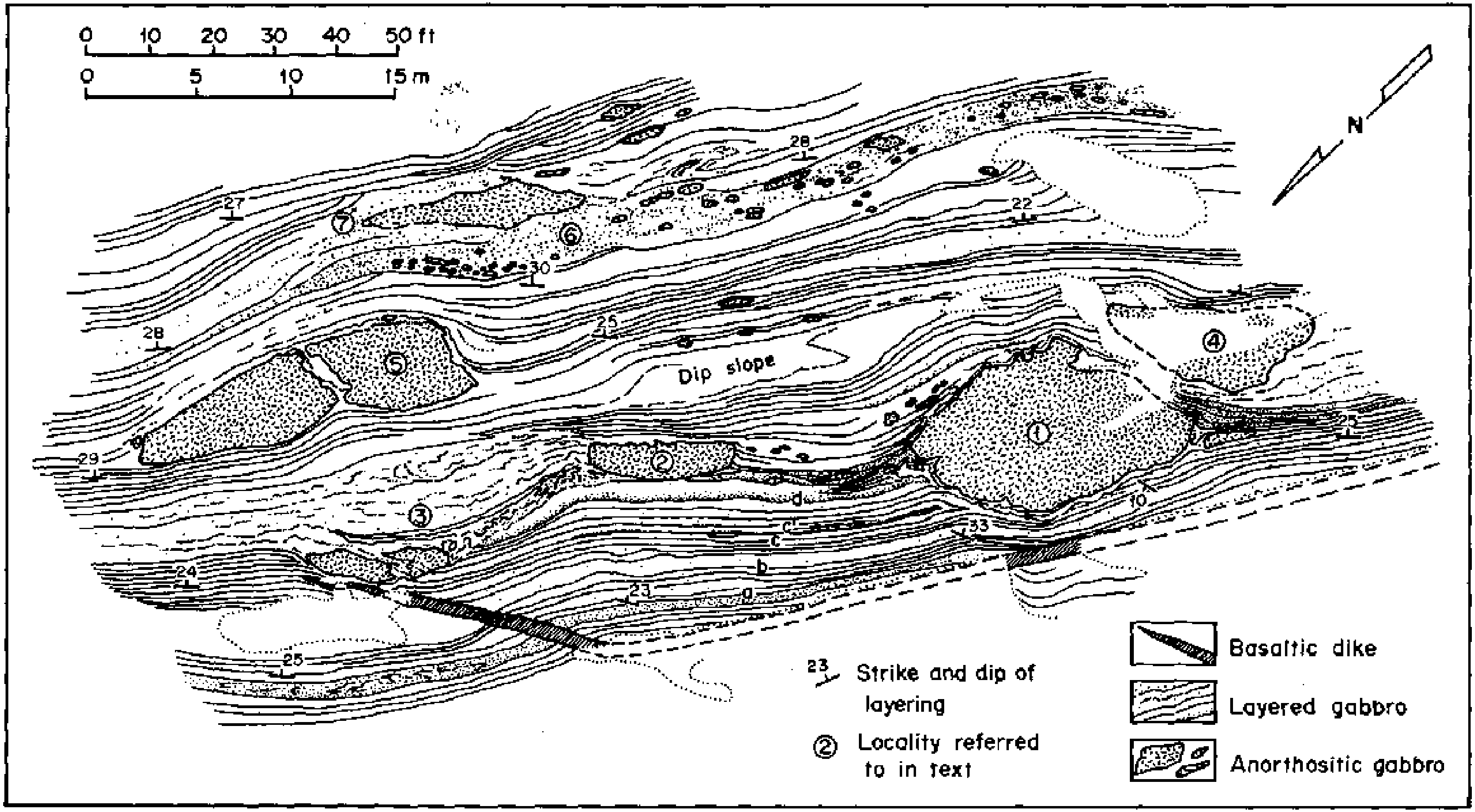
Figure 27. Two small blocks of gabbroic anorthosite in LZb, Uttentals Plateau. Note how the graded layers are smoothed over the lower block.



Bloco de anortosito que impactou camadas gradacionais quando em movimento para a esquerda, Skaergaard.

Figure 31. Convoluted layering in MZ, Kramers Island. The indicated drag direction is downdip.

Acamadamento fortemente convoluto, com camadas planares abaixo e acima, Skaergaard.



Estruturas associados a blocos de anortosito, Skaergaard

Figure 34. Olivine-rich layering in troctolite on an unconformity in the cross-bedded belt, LZa, Uttentals Plateau. Note the lateral facies changes, and a small fault at the right (Loc. 2, Fig. 44).

Figure. 35. Unconformity in the cross-bedded belt, Uttentals Plateau. Locality 5 in Fig. 44.

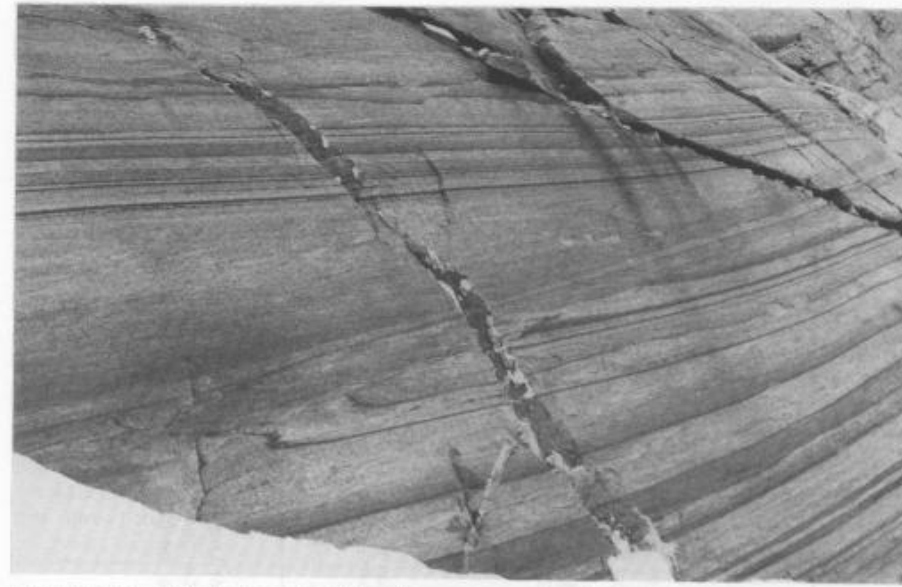


Figure 37. Low-angle unconformity, near trough A, UZa. The ends of the underlying layers are dragged to the right at the unconformity.

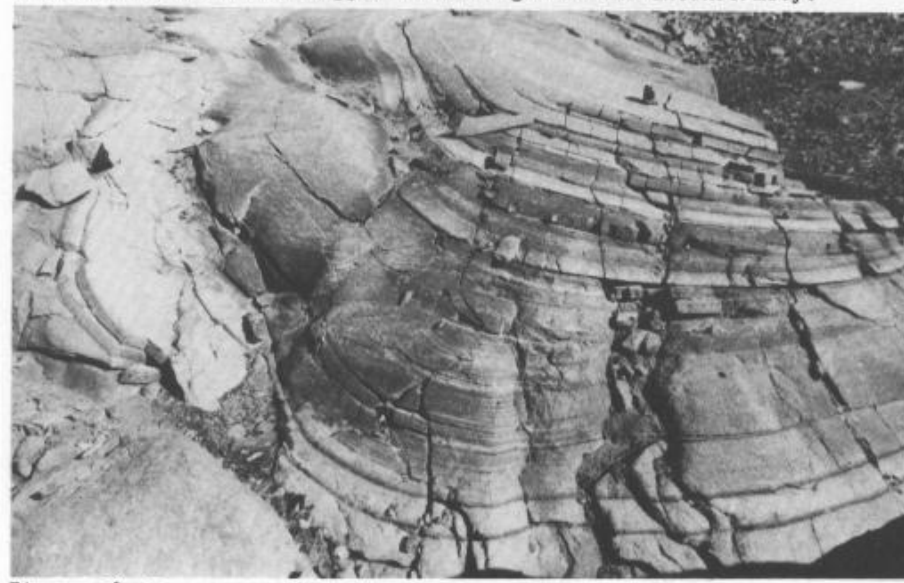


Figure 38. Trough in UZa, just north of trough E. Note the melanocratic axial layering and the leucocratic macrolayer at the bottom and left.

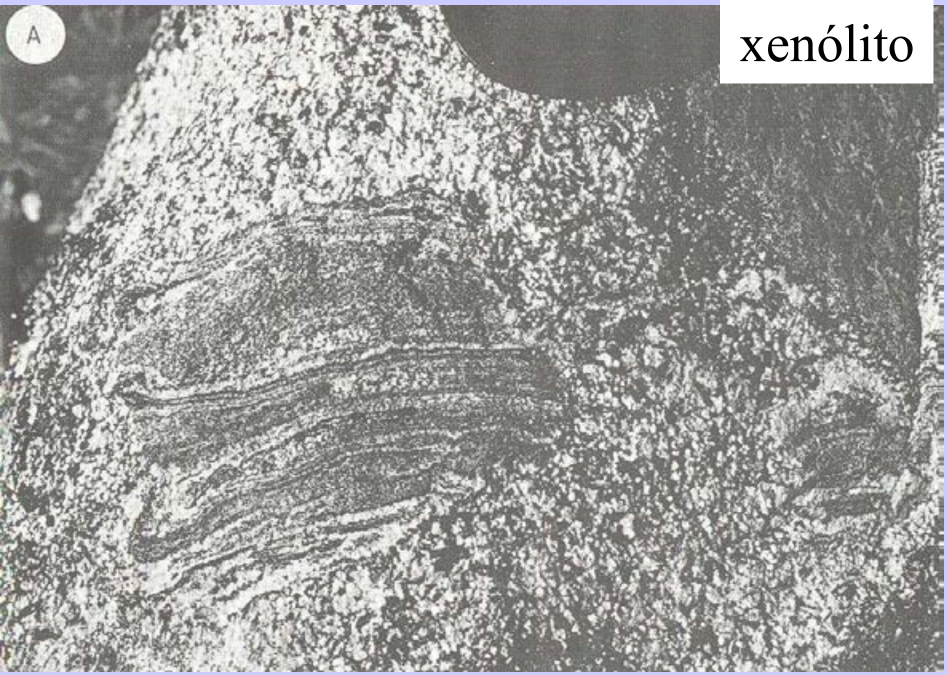
Canais, estratos cruzados e inconformidades, Skaergaard

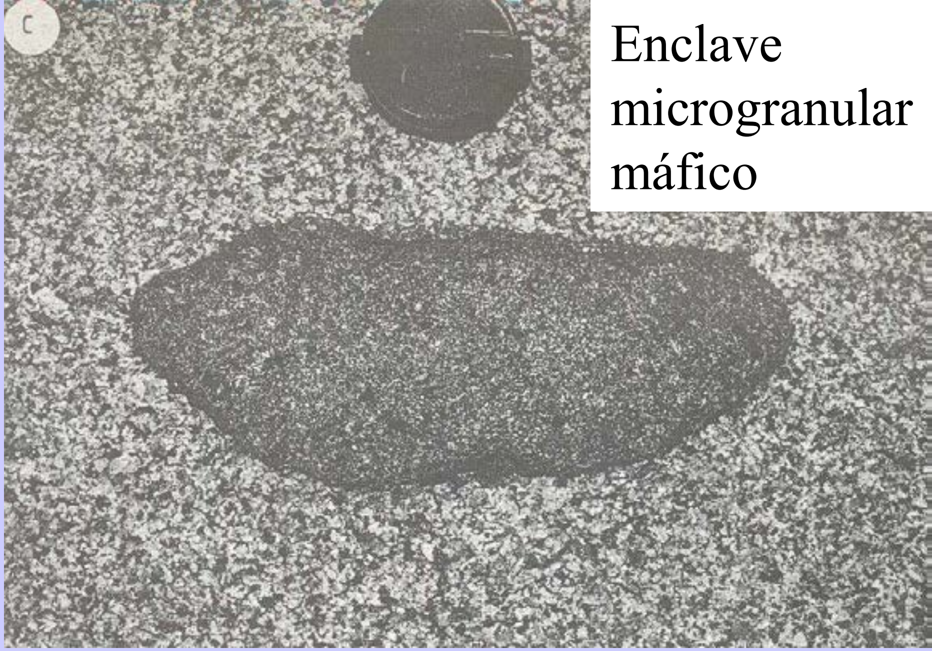
Skaergaard, acadamento gradacional normal

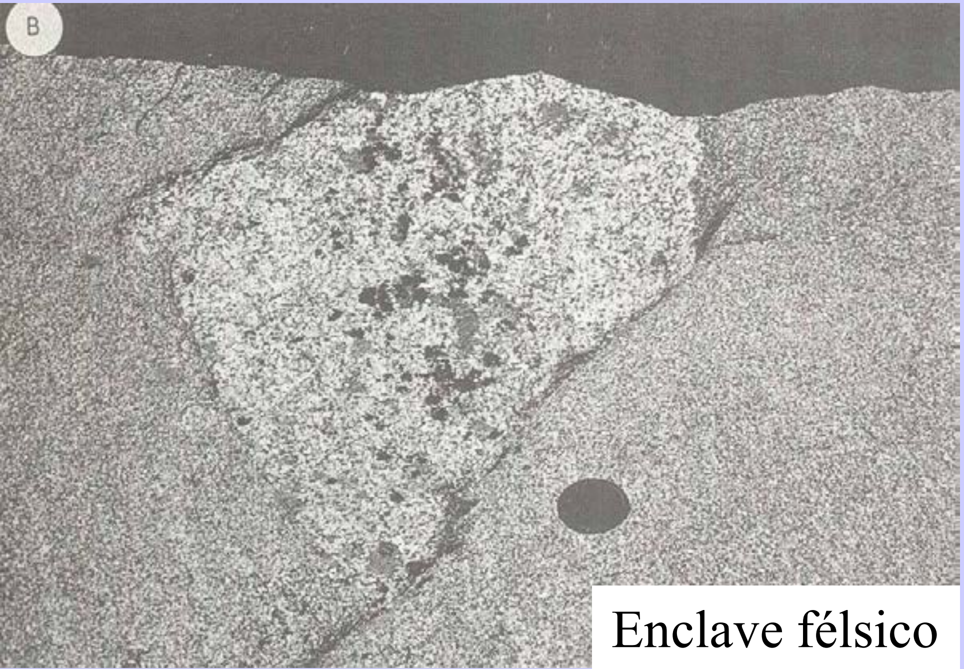
Skaergaard, seção macro-rítmica

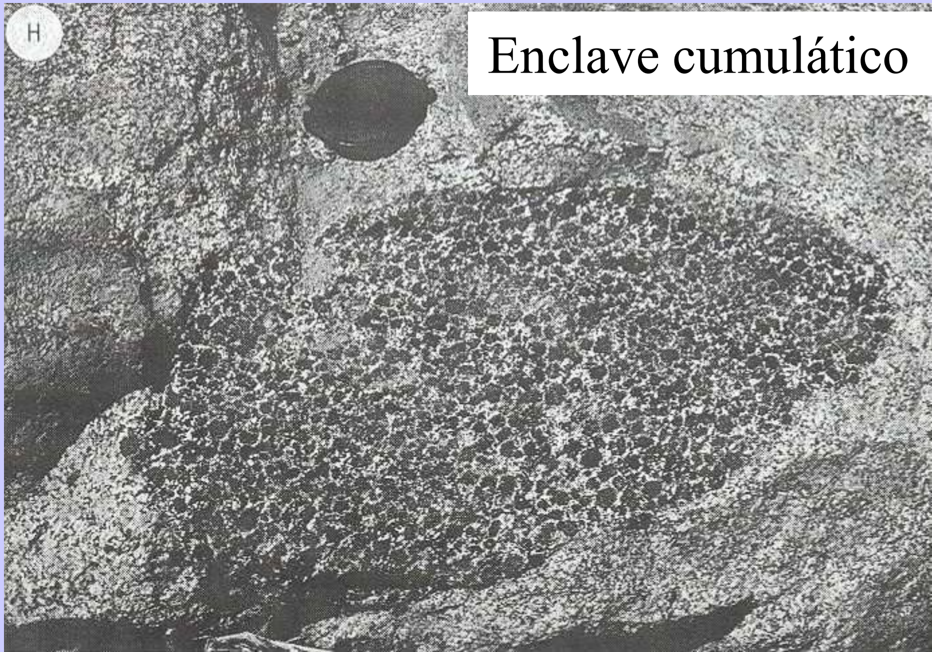
Enclaves

corpos estranhos isolados
dentro de rochas magmáticas


A
xenólito


C
Enclave
microgranular
máfico


B
Enclave félsico


H
Enclave cumulático

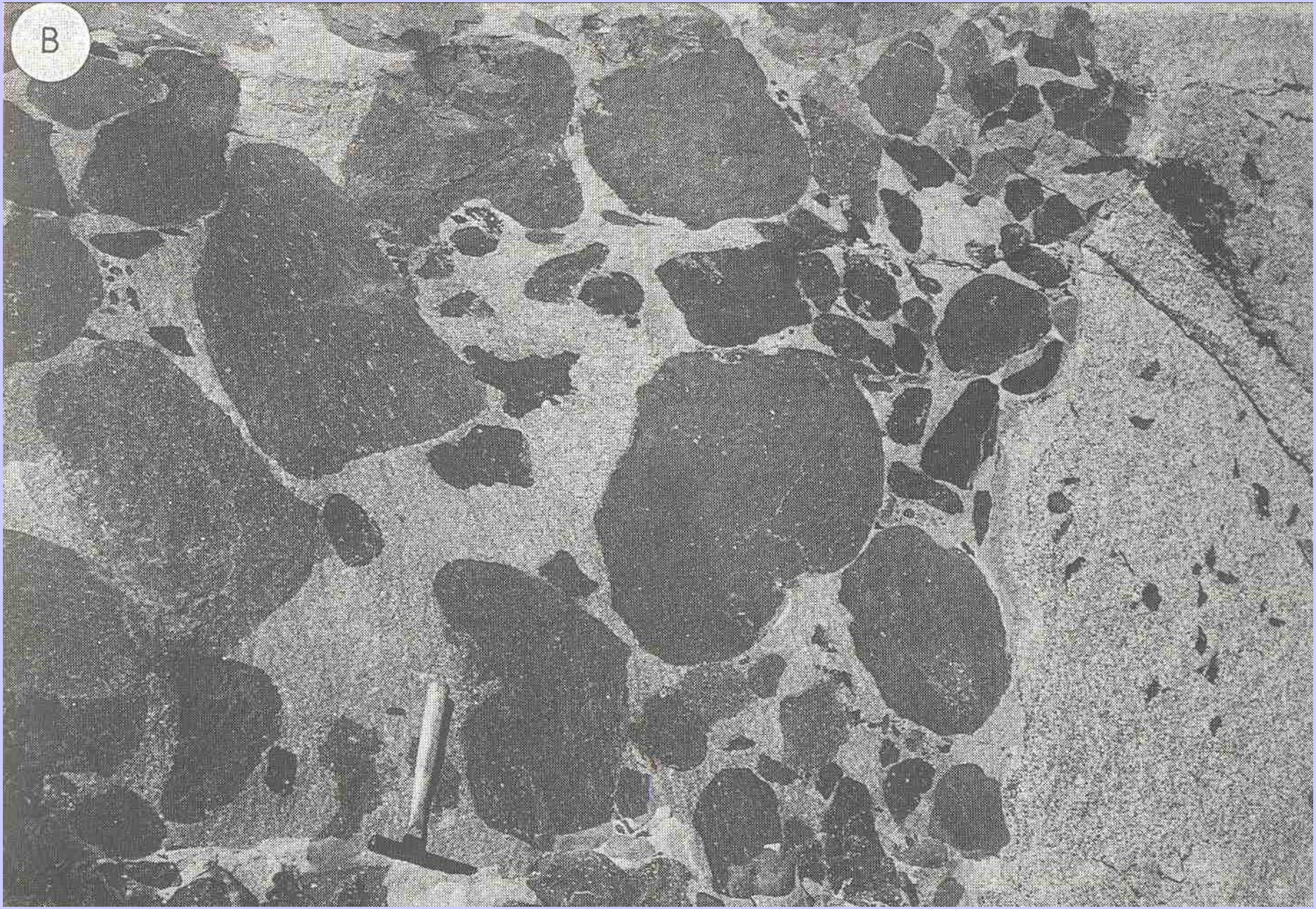
Termo	Origem	Contato	Forma	Feições
xenólito	Pedaço de rocha encaixante	abrupto	angulosa	Textura e mineralogia de metamorfismo de contato
xenocristal	Cristal estranho isolado	Abrupto	globular	Corrosão; auréola de reação
Enclave micáceo	Resíduo de fusão (restito)	Abrupto com crosta biotítica	lenticular	Textura metamórfica. Micas e Al-silicatos
Schlieren	Enclave disrupto	gradual	oblato	Orientação planar
Enclave microgranular félsico	Margem fina rompida	Abrupto ou gradual	ovóide	Textura ígnea, granulação fina
Enclave microgranular máfico	"Blob" de magma contemporâneo	Em geral, abrupto	ovóide	Textura ígnea, granulação fina
Enclave cumulático (autólito)	Cumulato disrupto	Em geral, gradual	ovóide	Textura cumulática, grossa

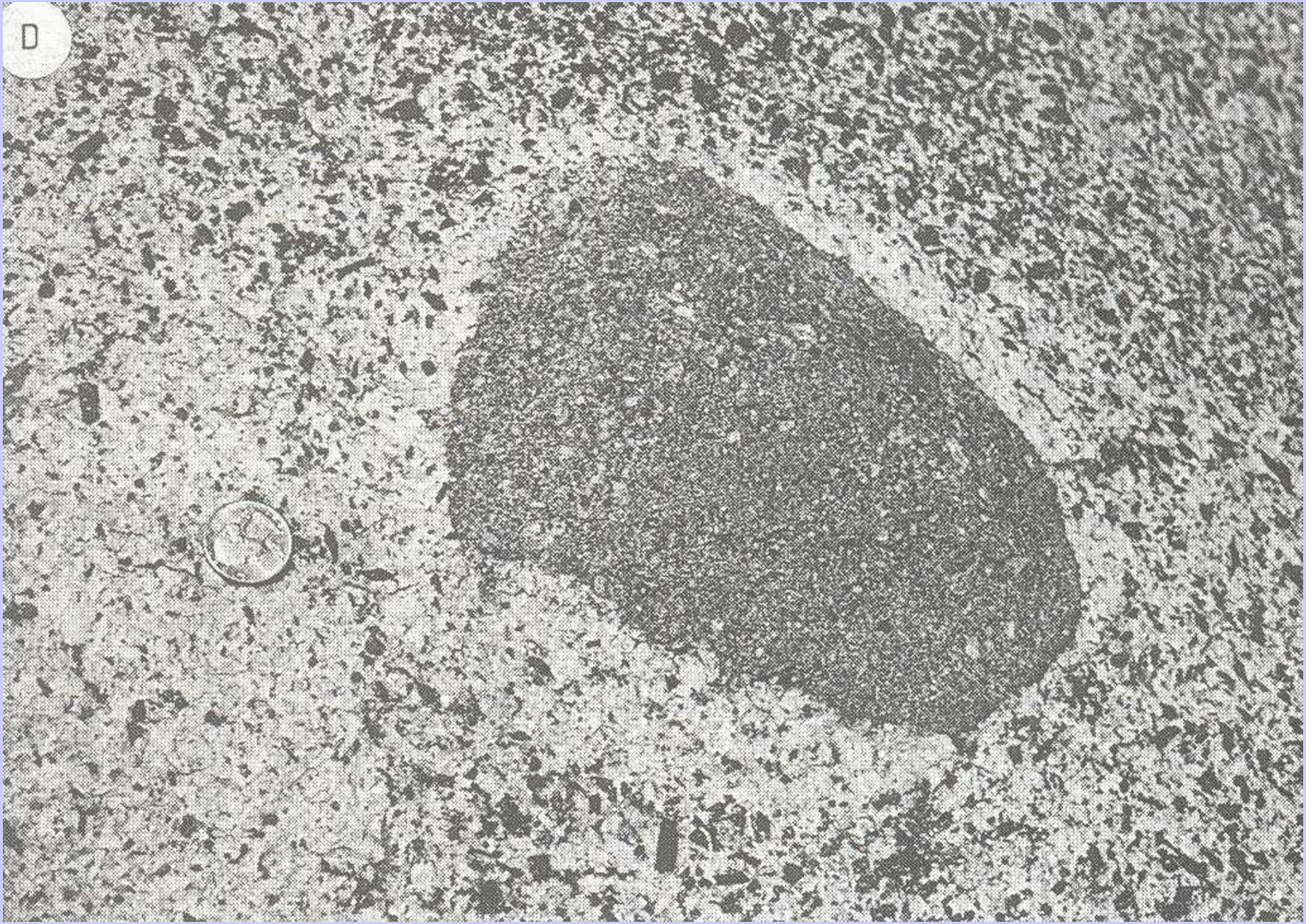
Os vários tipos de enclaves: sua natureza e principais feições petrográficas (segundo Didier & Barbarin, 1991, p. 19-23)

Aztec Wash Granite,

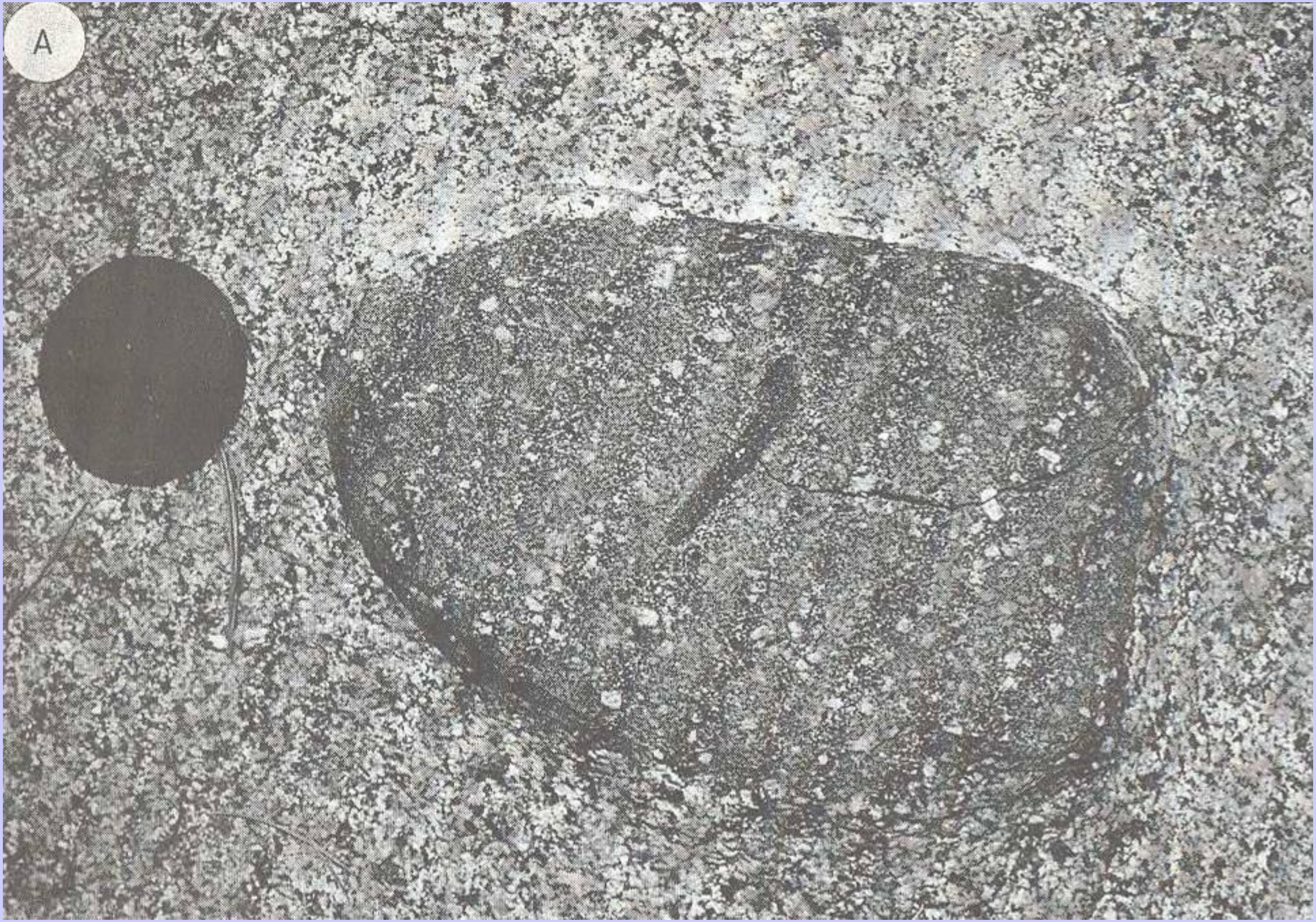
Nevada, USA

Enclave microgranular félsico com borda mais escura, Mogi das Cruzes, SP


B

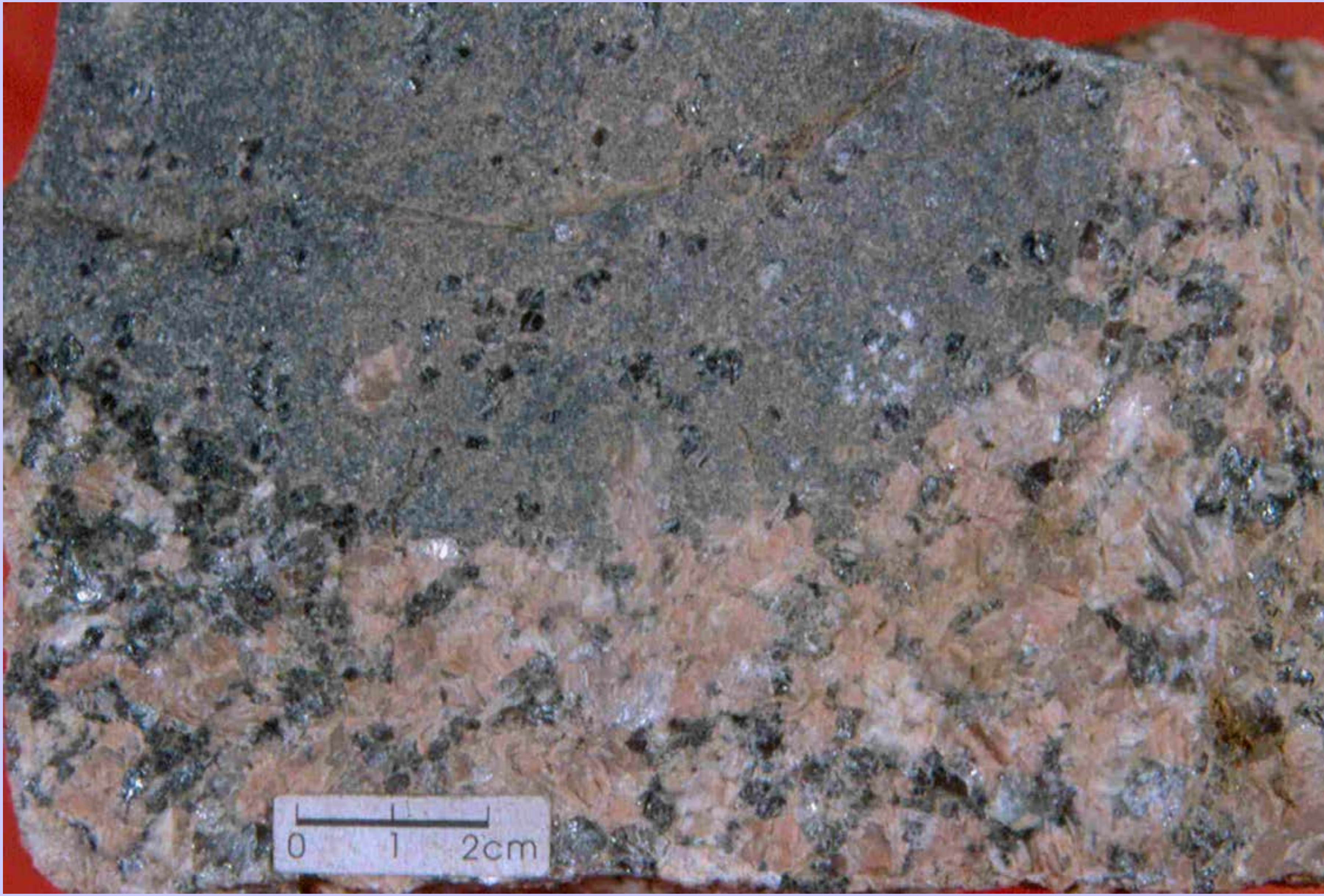


Enclave microgranular com auréola de concentração de minerais félsicos, Sierra Nevada, Califórnia


A

Enclave duplo, Mogi das Cruzes, SP

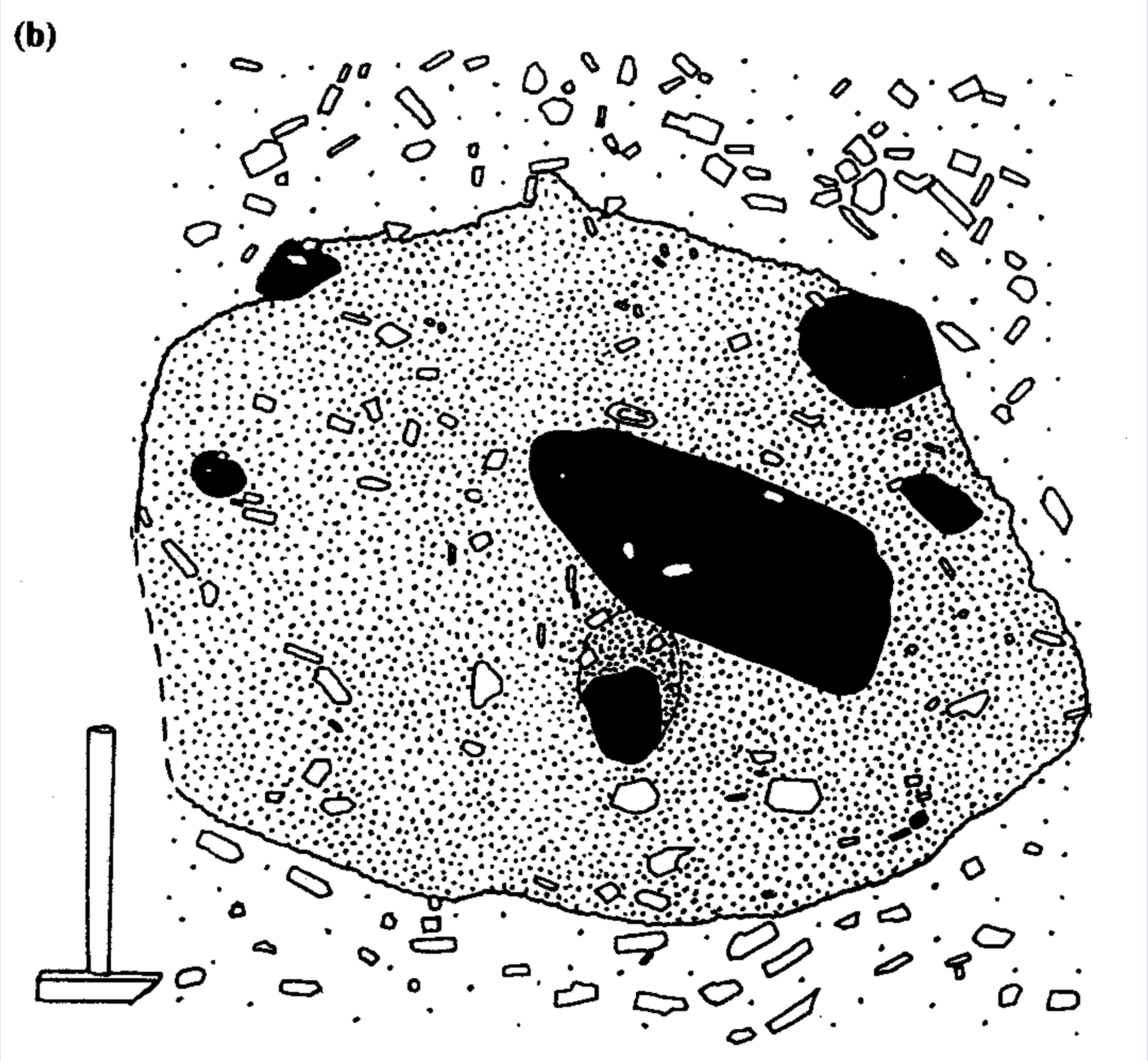
Enclave rico em xenocristais, Mauá, SP



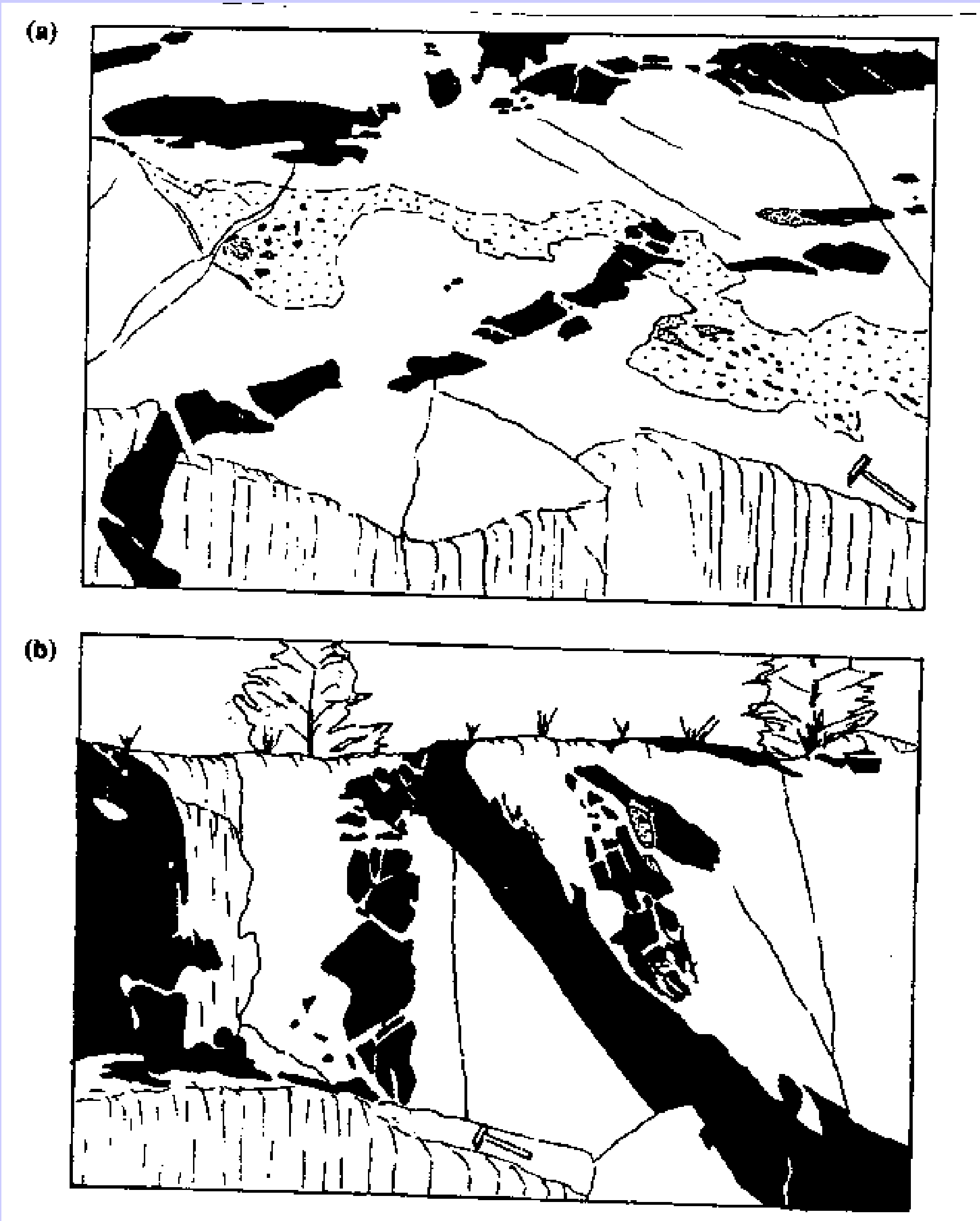
enclave em granito, com quartzo incluído

Enclave com xenocristais de quartzo e Kfs, granito rapakivi, Rondônia

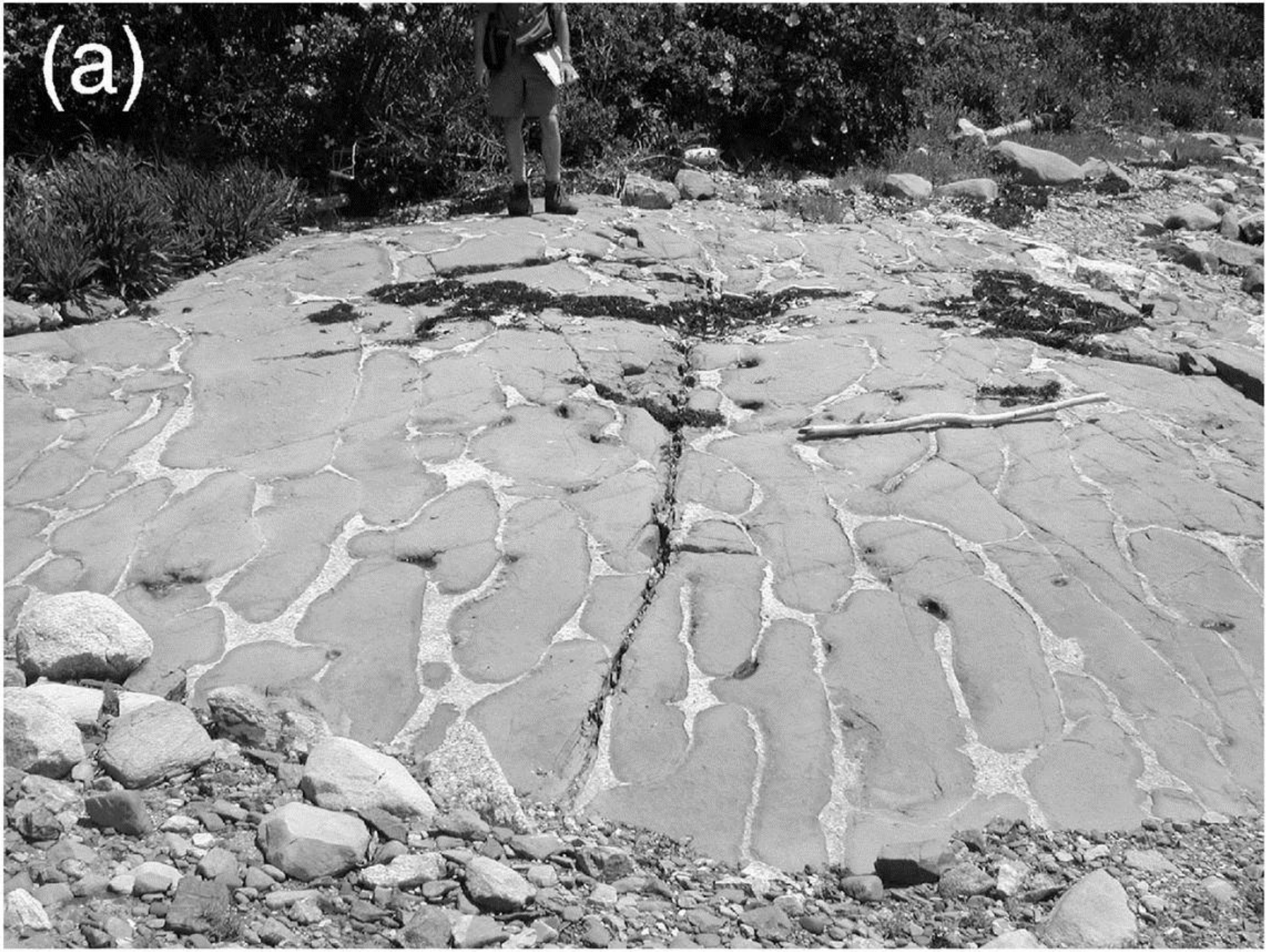
enclave duplo em granito rapakivi, Rondônia



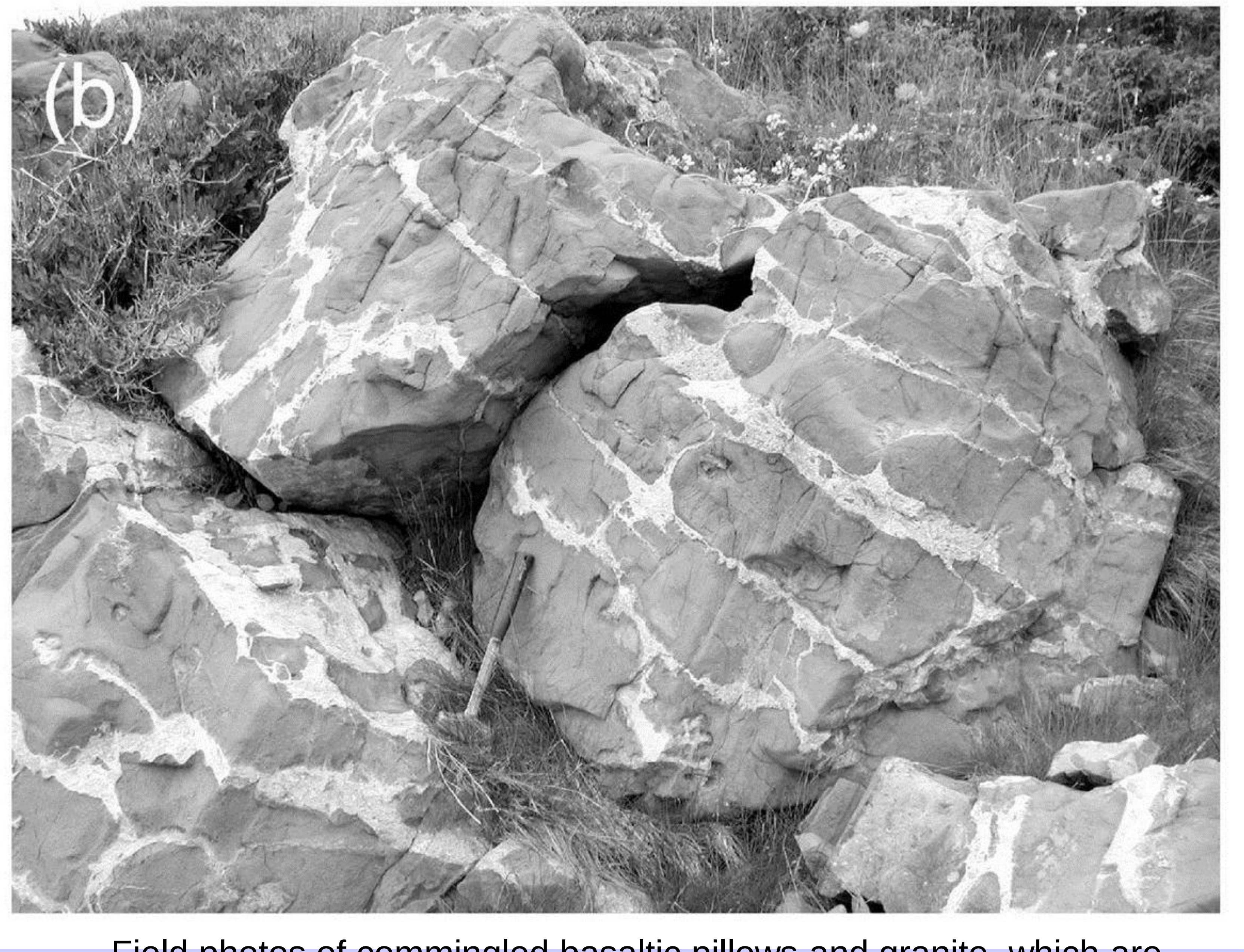
Enclaves duplos: estágios progressivos de hibridização?



Esboços de campo: relação entre enclaves microgranulares máficos e diques sin-plutônicos



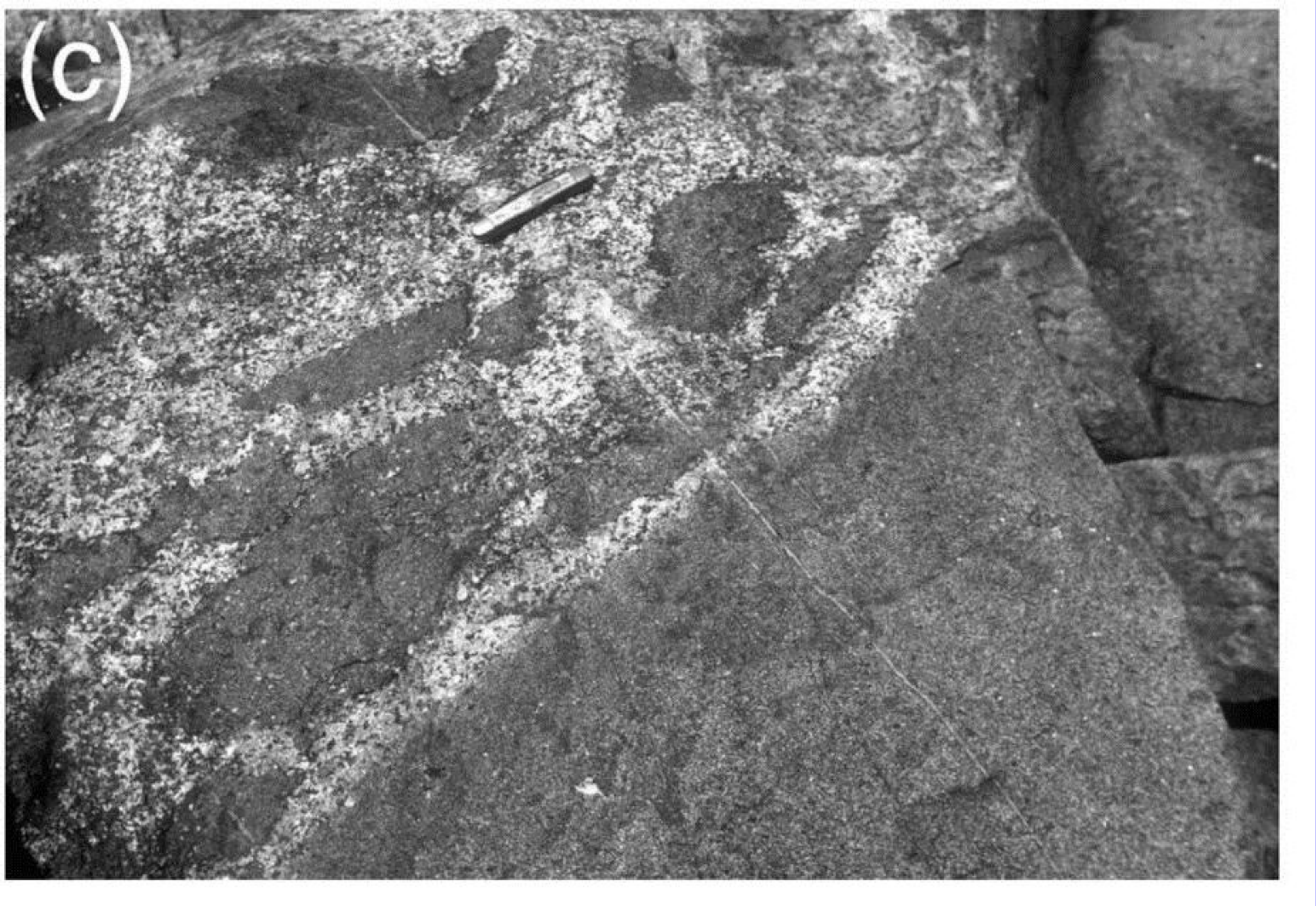
Field photos of commingled basaltic pillows and granite, which are features once termed net-vein complexes. (**a**) Vinalhaven intrusive complex.



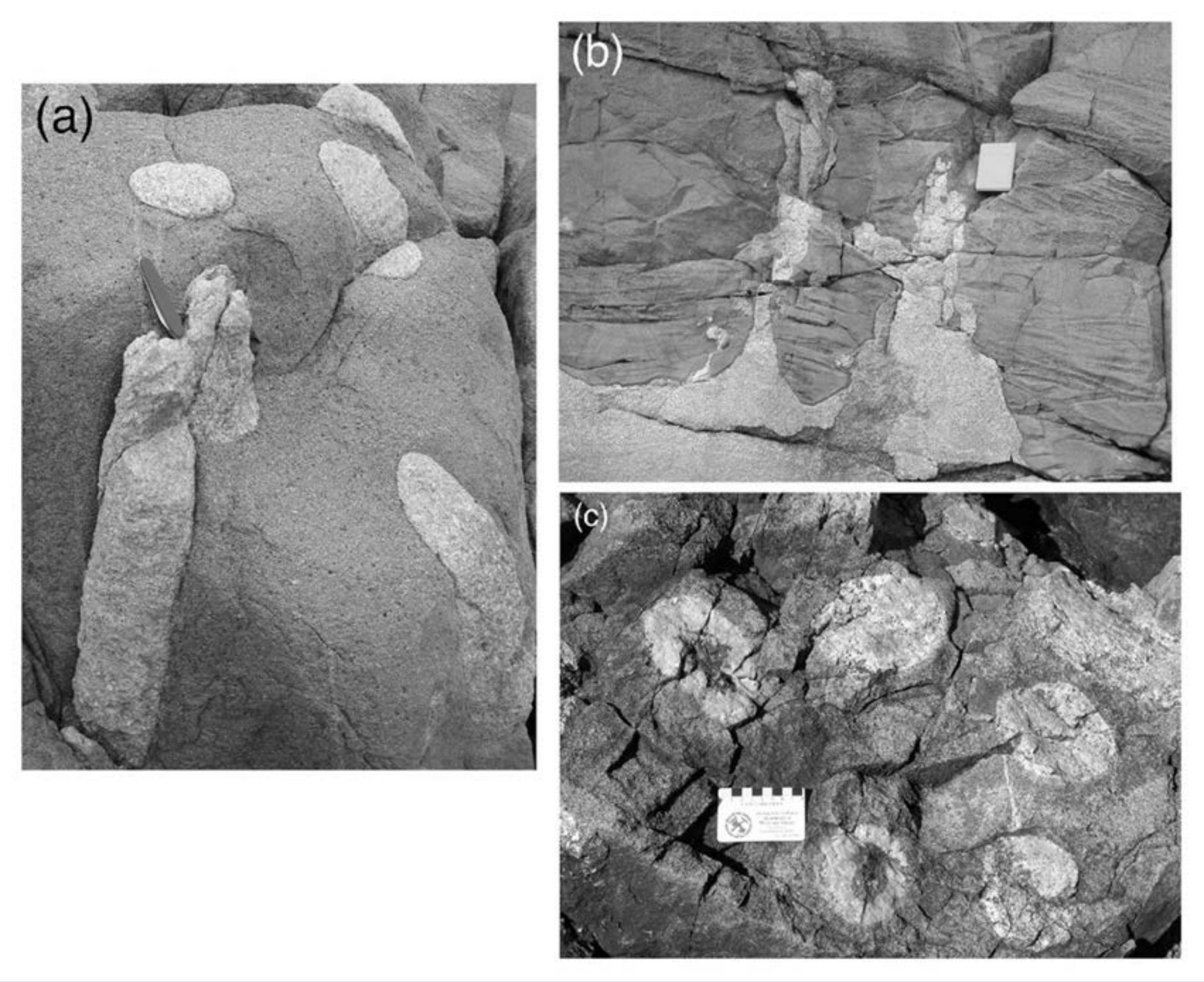
Field photos of commingled basaltic pillows and granite, which are features once termed net-vein complexes. (**b**) Interior of a composite dike that cuts layered gabbro, Vinalhaven. (Photos: R.A. Wiebe.)

Commingling in Austurhorn, Iceland. (**b**) Chilled base of a thicker basaltic layer resting on **hybridized felsic material, that grades downward to the disrupted top of an underlying layer**. Note leucogranite upwelling between the mafic lobes. This likely represents **filter-pressed interstitial liquid within the hybrid felsic material**. (Photos: R.A. Wiebe.)

Field photos of field relations in Ingonish intrusion. (**b**) Chilled base of a thicker porphyritic basaltic layer resting on hybrid diorite with mafic enclaves. (Photos: R.A. Wiebe.)



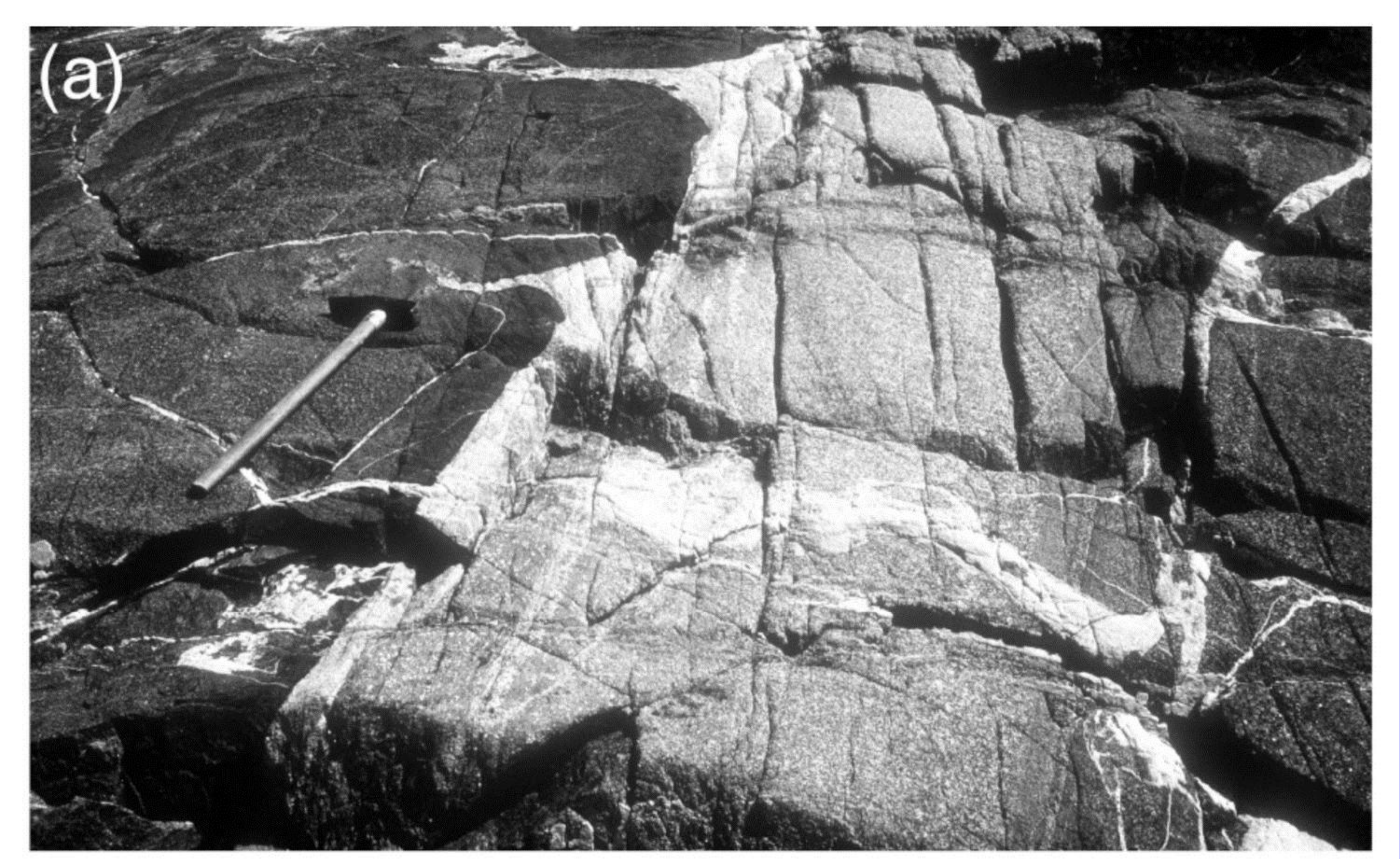
Field photos of field relations in Ingonish intrusion. (**c**) Unchilled top of a thick basaltic layer with enclaves in overlying diorite that decrease upward in size. (Photos: R.A. Wiebe.)



Silicic pipes fed by underlying felsic cumulates beneath the base of mafic replenishments. (**a**) 3D view of pipes (Vinalhaven intrusion). (**b**) Vertical outcrop displays a section approximately parallel to the pipe axes (Vinalhaven intrusion). (**c**) Horizontal surface approximately perpendicular to pipe axes. These pipes vary upward in composition from granite near the base to pegmatite and open vugs at higher levels (Pleasant Bay intrusion). (Photos: R.A. Wiebe.)

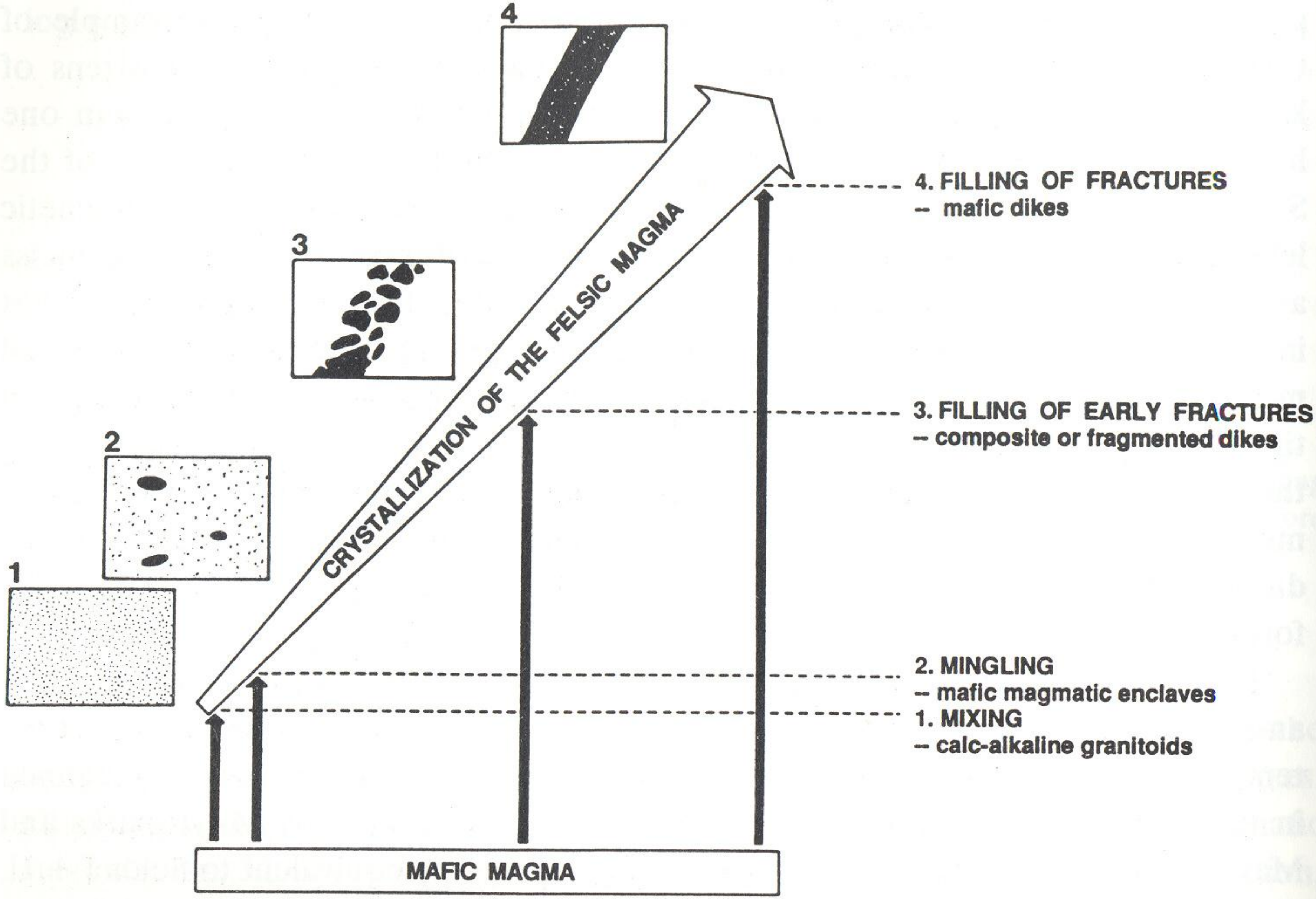
A thin chilled basaltic layer terminates to the right and presumably flowed in that direction. Felsic pipes that penetrated the chilled base of the layer and rose upward, curving to the right, reflecting continued flow after the pipe initiated. By the time the pipes approached the upper margin of the mafic flow a chilled margin had been established, which trapped the upwelling felsic material (Cadillac Mountain intrusive complex). (Photo: R.A. Wiebe.)

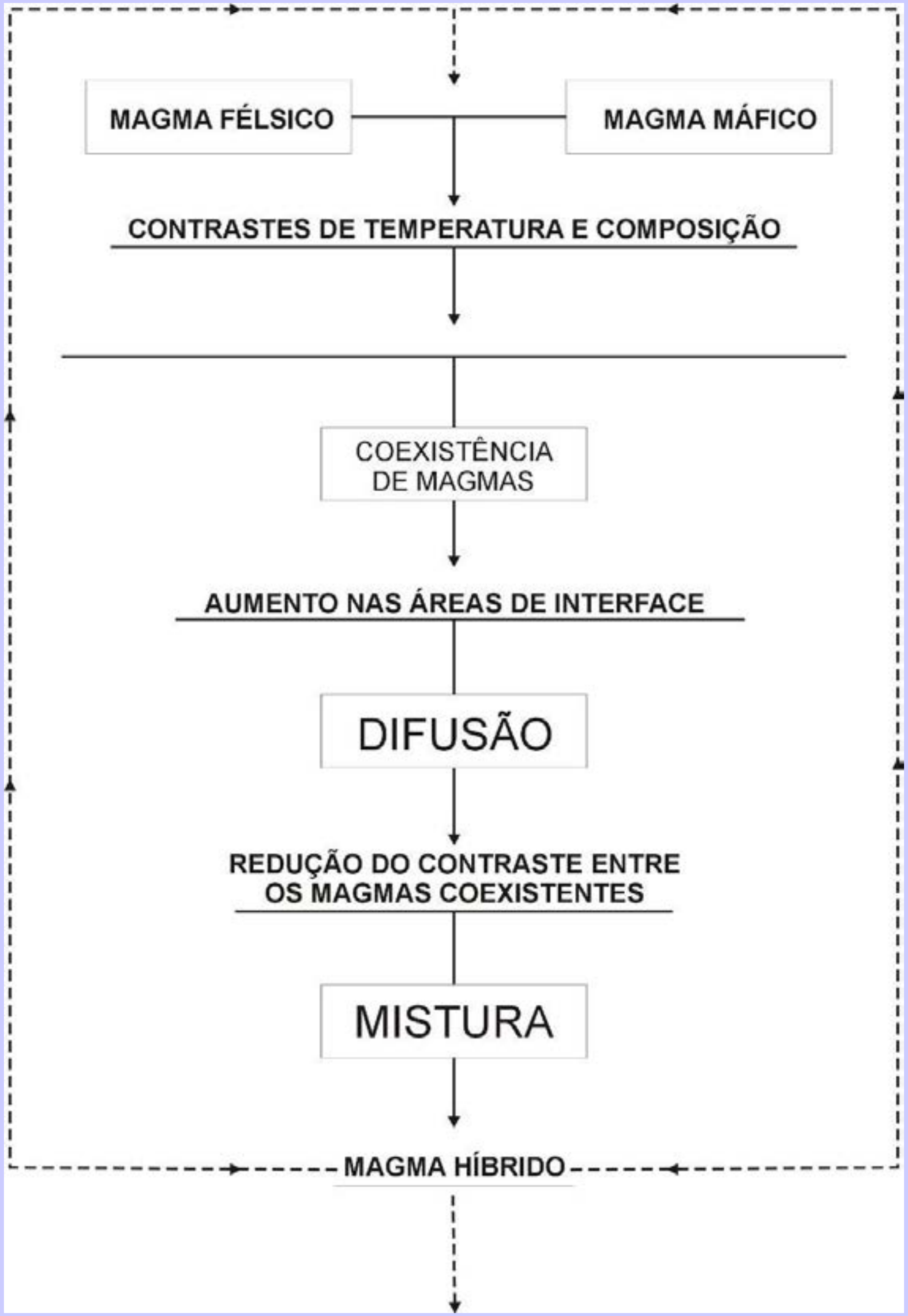
Thin mafic layers **chilled on base and top** that were sequentially emplaced onto hybrid cumulate material as the chamber floor was aggrading (Pleasant Bay intrusion). (Photo: R.A. Wiebe.)



Gradational compositional variation in macrorhythmic layers. (**a**) Top to the left. Gradation from gabbro upward to felsic cumulate within about 1 m. Overlying basally chilled gabbro layer cut by diapiric felsic material fed from the top of the gradational layer (Cadillac Mountain intrusive complex). (Photos: R.A. Wiebe.)

Gradational compositional variation in macrorhythmic layers. (**b**) Comparable relations in the Pleasant Bay intrusion. Here a chilled mafic lens within the gradational layer caused interstitial melt within the hybrid cumulate to be trapped and collect along its lower margin. (Photos: R.A. Wiebe.)


4
3
2
1
CRYSTALLIZATION OF THE FELSIC MAGMA
4. FILLING OF FRACTURES
-- mafic dikes
3. FILLING OF EARLY FRACTURES
-- composite or fragmented dikes
2. MINGLING
-- mafic magmatic enclaves
1. MIXING
-- calc-alkaline granitoids
MAFIC MAGMA



MAGMA FÉLSICO
MAGMA MÁFICO
CONTRASTES DE TEMPERATURA E COMPOSIÇÃO
COEXISTÊNCIA DE MAGMAS
AUMENTO NAS ÁREAS DE INTERFACE
DIFUSÃO
REDUÇÃO DO CONTRASTE ENTRE OS MAGMAS COEXISTENTES
MISTURA
MAGMA HÍBRIDO