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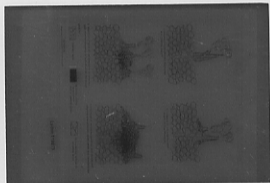
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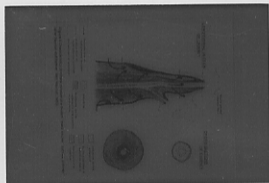
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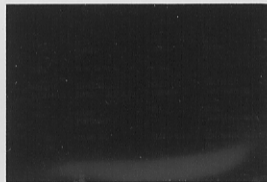
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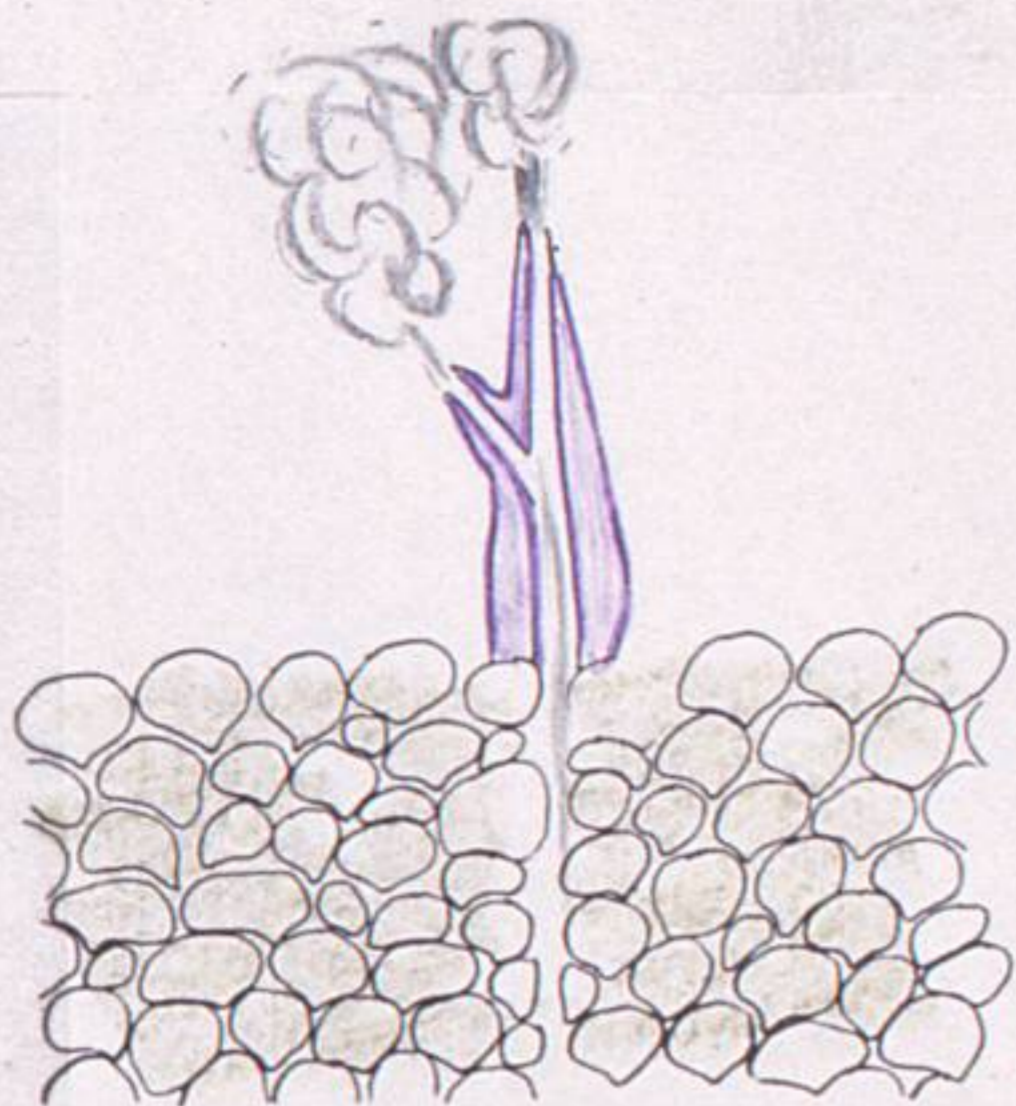
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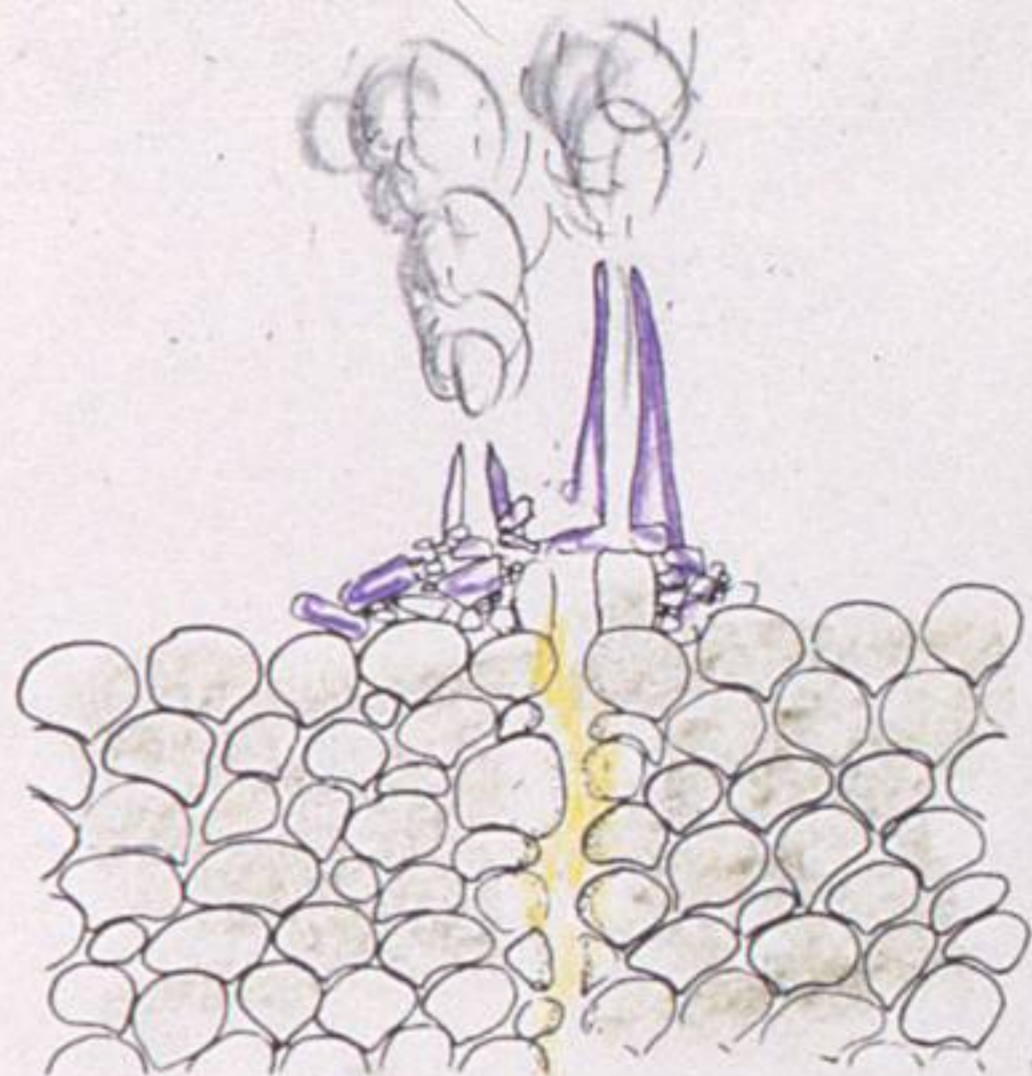
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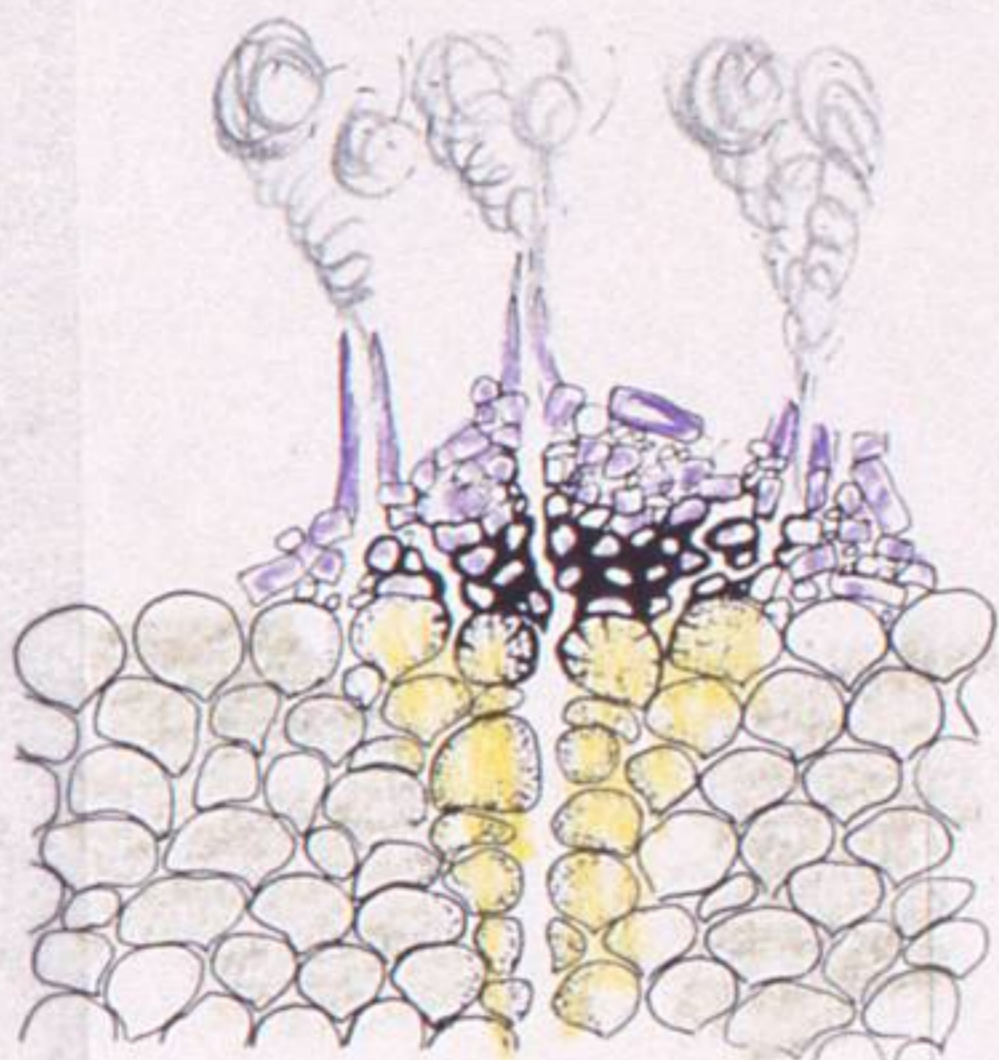
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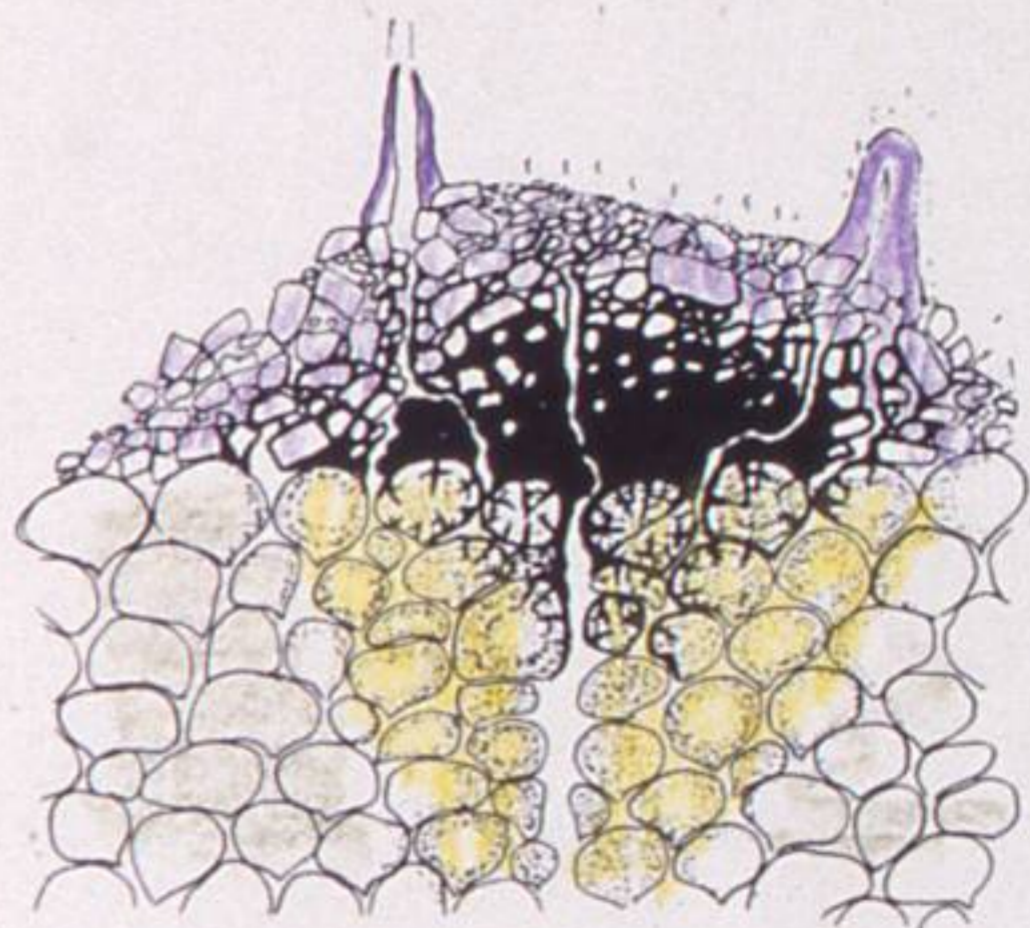
1. Initiation of hydrothermal discharge and chimney growth



2. Collapse of old chimney and growth of new chimneys

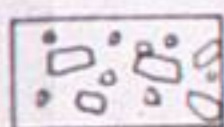


3. Growth of mound by accumulation of chimney talus and defocussing of hydrothermal discharge



4. Decrease of mound permeability and intramound sulphide precipitation, replacement and remobilization

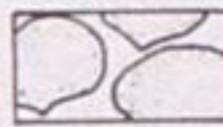
LEGEND:



Chimney talus



Sulphide infilling,
replacement
and/or remobilization



Hydrothermal alteration
of pillow lavas

10 meters

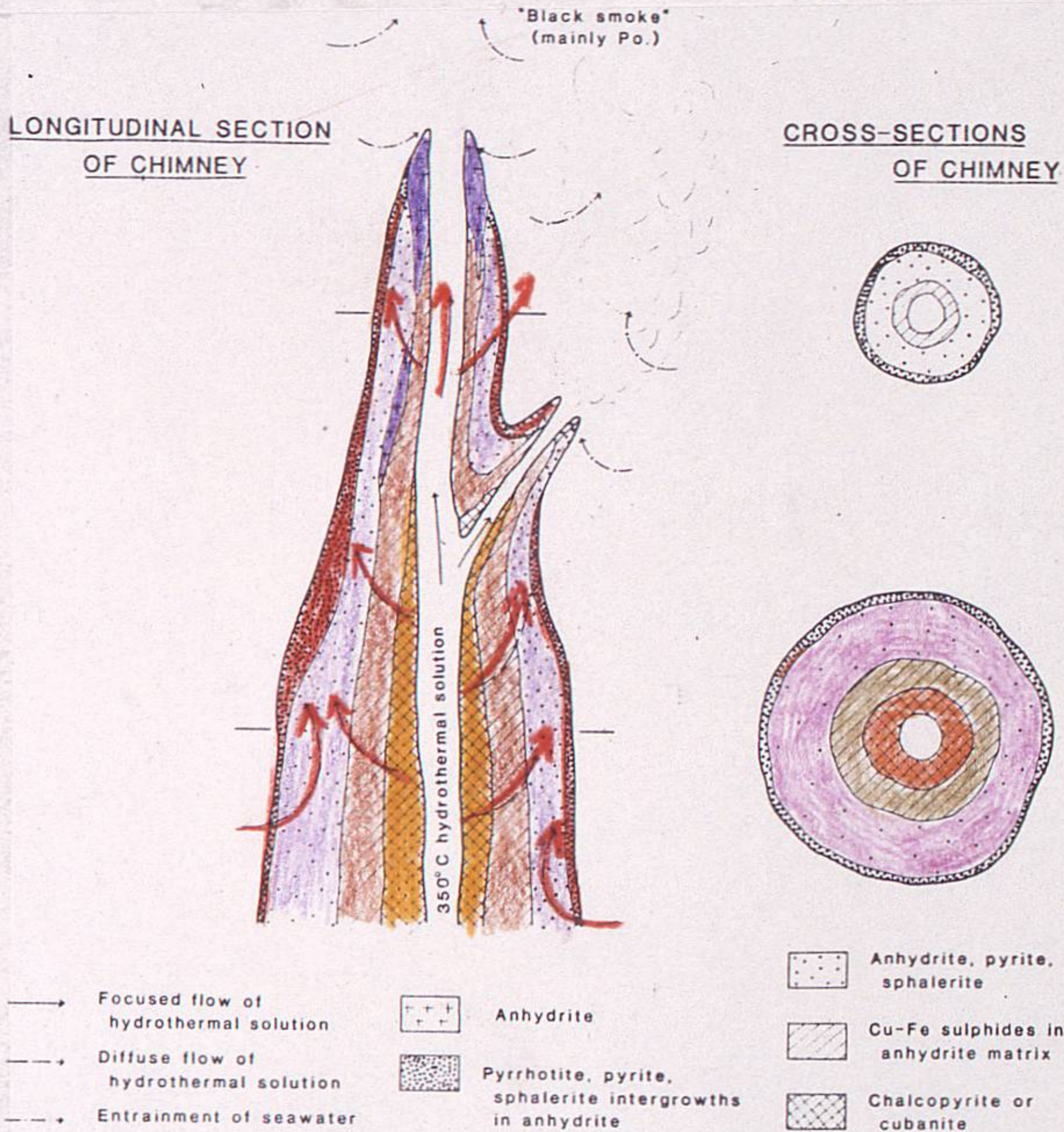


Figure 3 Characteristics of mineral zonation of a modern "black smoker" sulphide chimney. (After Haymon and Kastner, 1981; Haymon, 1983).

	Zn-Pb-Cu (KUROKO)	Cu-Zn (CYPRUS)	Cu-Zn (BESSHI)
ALTERATION	STRINGER ZONE - CHLORITE - SILICIFICATION - SERICITIC - "SULPHATES"	STRINGER ZONE - CHLORITIC - SILICIFICATION - Fe(Mn) CHERT	? - CHLORITIC - SILICIFICATION - Fe(Mn) CHERT
EXAMPLES	BRITANNIA REA WESTMIN	ANYOX CHU CHUA	GOLDSTREAM GRANDUC WINDY CRAGGY (?)

	Zn-Pb-Cu (KUROKO)	Cu-Zn (CYPRUS)	Cu-Zn (BESSHI)
TENOR	Pb-Zn-Cu-Ag-Au	Cu-(Zn)	Cu-Zn (Pb)
VOLCANIC ASSOCIATION	DIFFERENTIATED, BINODAL, CALC-ALKAL	THOLEIITIC (GABBRO)	THOLEIITIC (CALC-ALKALINE ?)
HOST	FELSIC PYROCLASTIC	BASALT	BASALT TERRIGENOUS ROCKS
TECTONIC SETTING	ISLAND ARC	OCEANIC RIDGE	CONTINENTAL MARGIN (BACK-ARC ?)

Pb-Zn-Cu

Cu-Zn

KUROKO

BESSHI

CYPRUS

TENOR

Pb - Zn - Cu

Cu - Zn

Cu - (Zn)

VOLCANIC ASSOCIATION

DIFFERENTIATED
CALC-ALKALINE

BASIC
CALC-ALKALINE (?)

THOLEIITIC
BASALT -
(GABBRO)

HOST

FELSIC
PYROCLASTICS

BASALT
TERRIGENOUS ROCKS

BASALT

TECTONIC ENVIRONMENT

ISLAND ARC

CONTINENTAL
MARGIN
BACK ARC (?)

OCEANIC RIDGE

ALTERATION

STRINGER ZONE
Mg - Si
K HALO
SULPHATES

(?)
Mg - Si

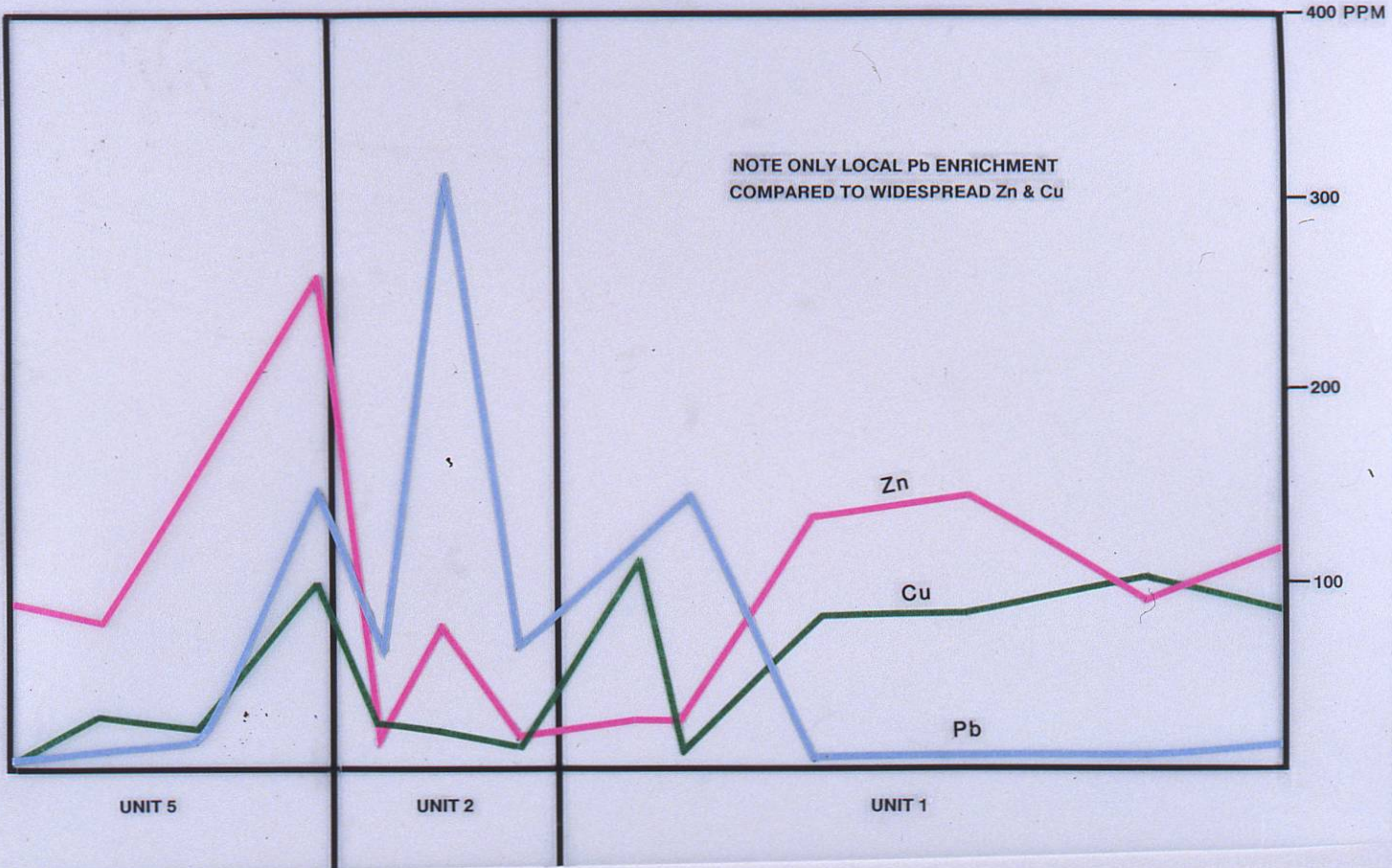
Fe-Mn CHERT

STRINGER ZONE
Mg - Si
OCHRE
Fe (Mn) CHERT

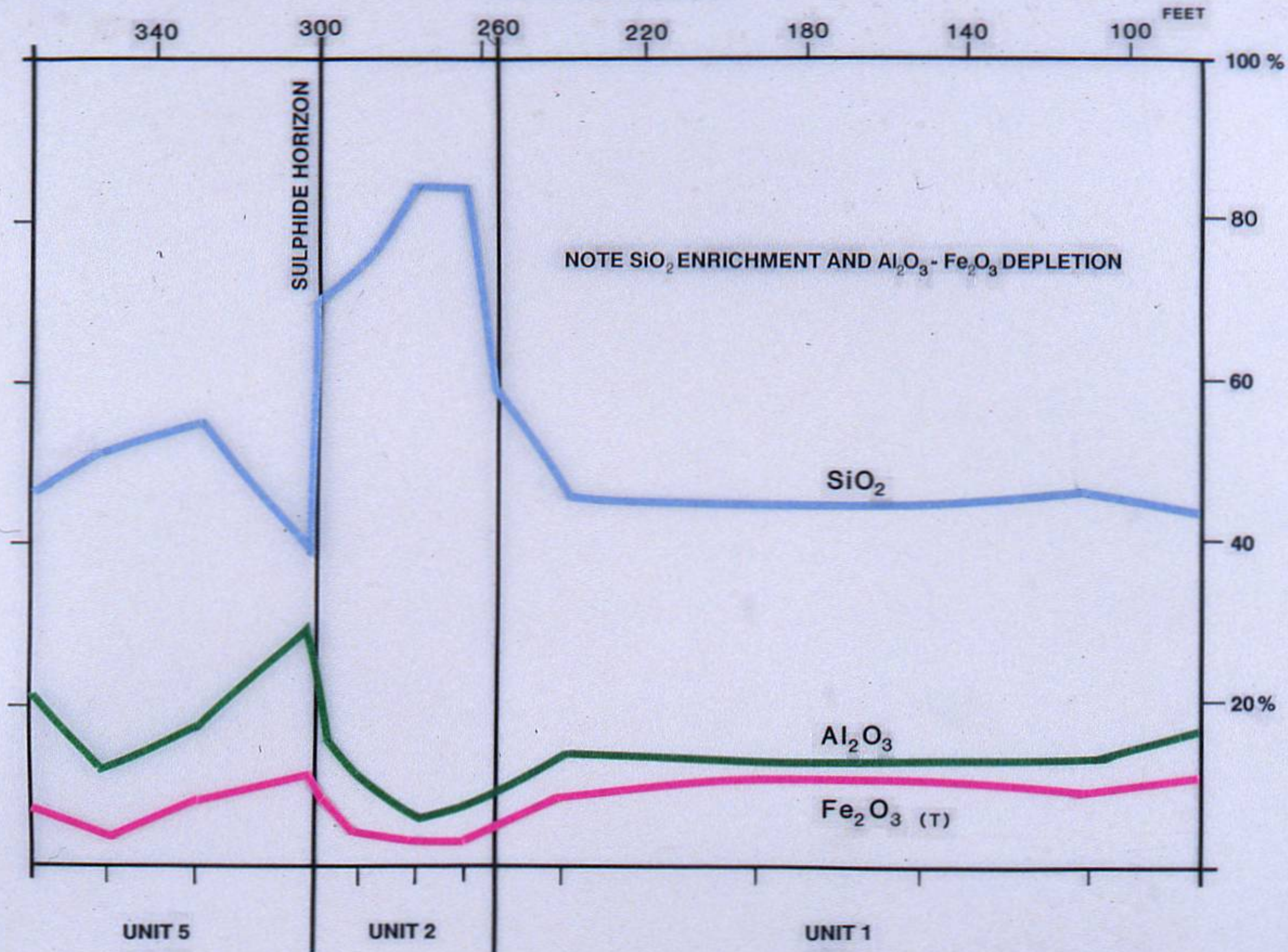
AGE OF CORDILLERAN MASSIVE SULPHIDE DEPOSITS

AGE	VOLCANOGENIC DEPOSITS	OTHER DEPOSITS	TECTONISM
TERTIARY	TERRANE 2 TERRANE 1 (SUNRO)	} PORPHYRY Mo	↑↓ TERRANE 2 ACCRETED
CRETACEOUS			
JURASSIC	BRITANNIA SENECA ANYOX, GRANDUC	} PORPHYRY Cu, Au	↑↓ TERRANE 1 ACCRETION
TRIASSIC	WINDY - CRAGGY KUTCHO CREEK		
LATE PALEOZOIC	ECSTAL WESTMIN, CHU CHUA HOMESTAKE, REA		
MID PALEOZOIC			
EARLY PALEOZOIC	GOLDSTREAM	PLATFORM Pb-Zn	PLATFORM BUILDING
PROTEROZOIC		CLASTIC Pb-Zn	CONTINENTAL RIFTING

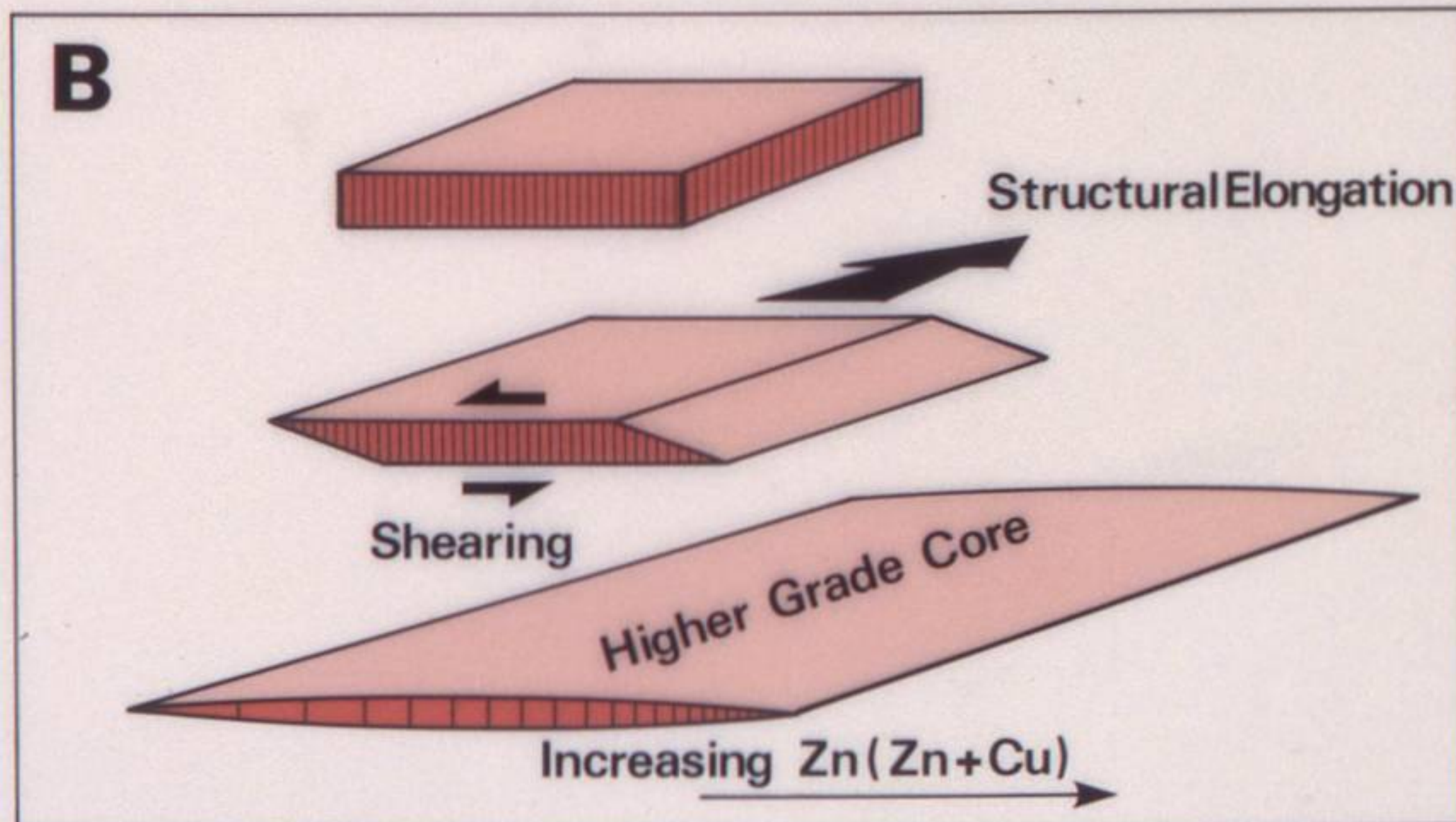
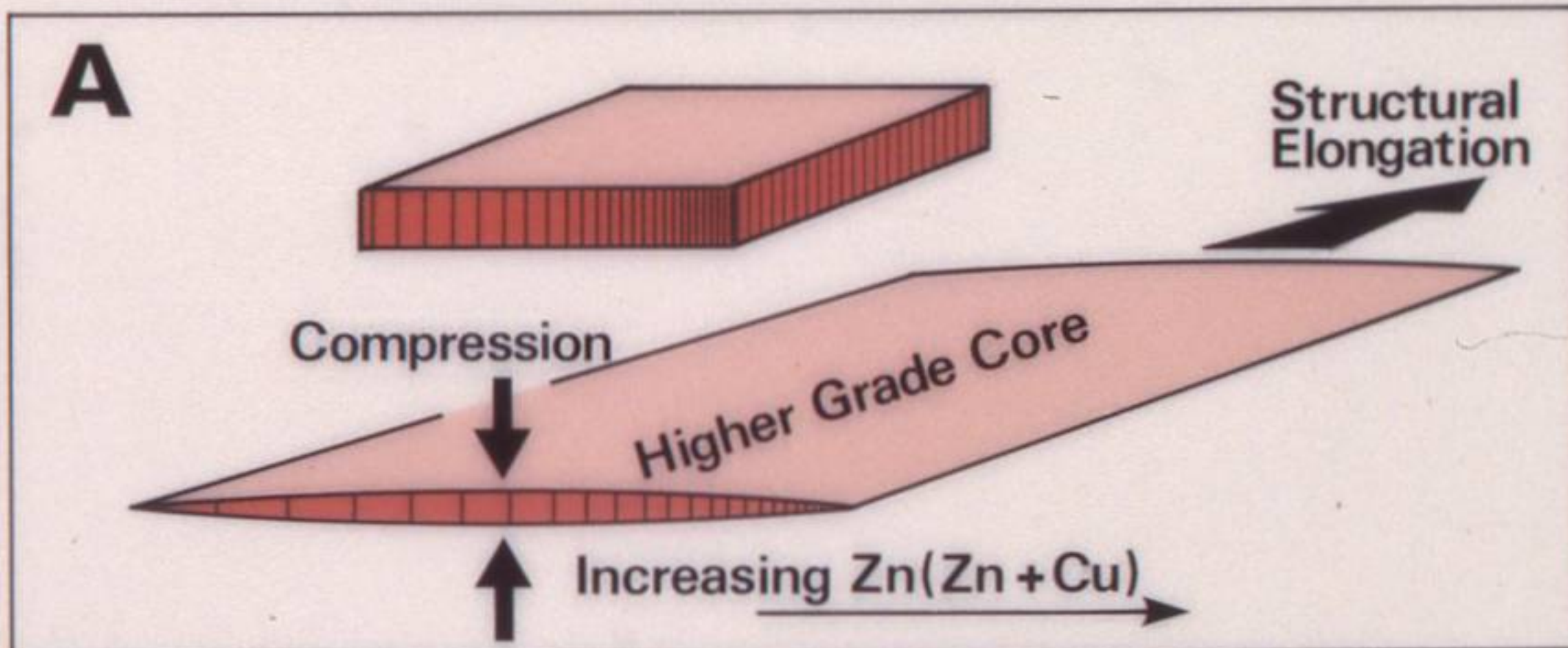
REA - L97 LENS



REA - L97 LENS

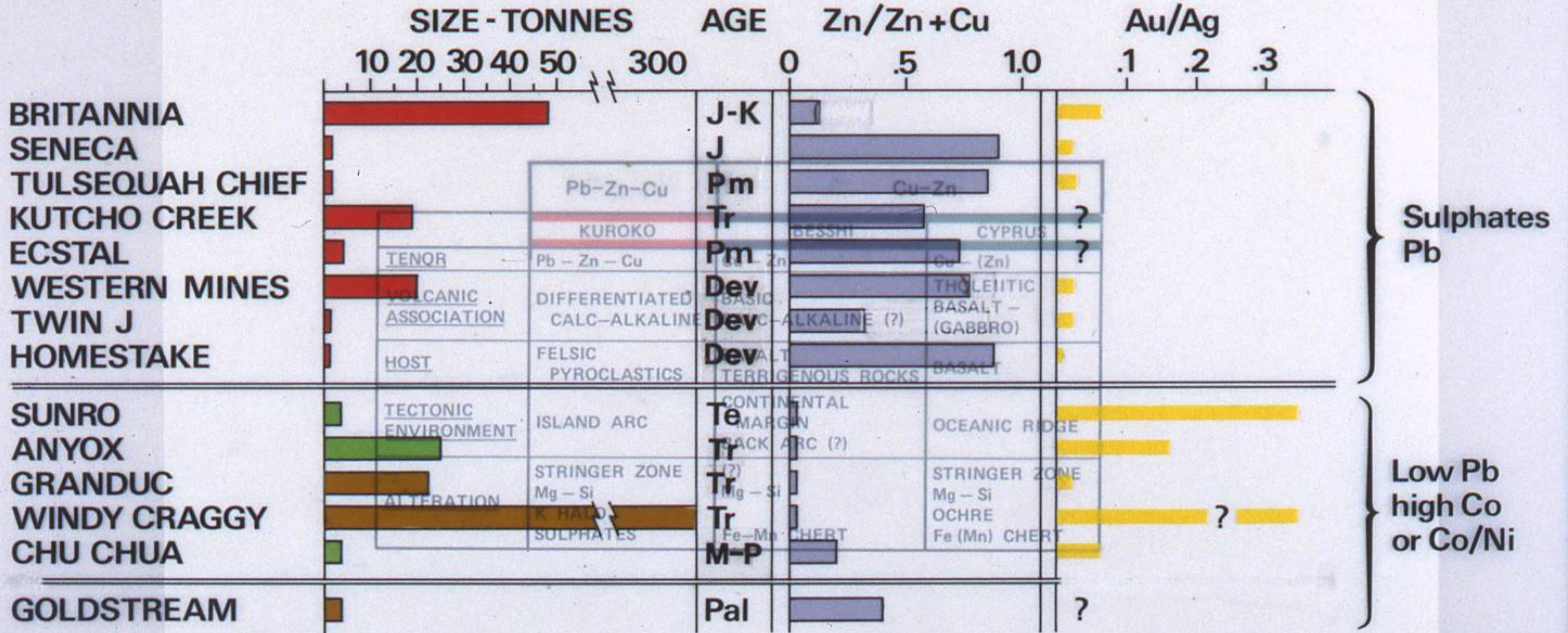


STRUCTURAL EVOLUTION OF GOLDSTREAM MASSIVE SULPHIDE LENS

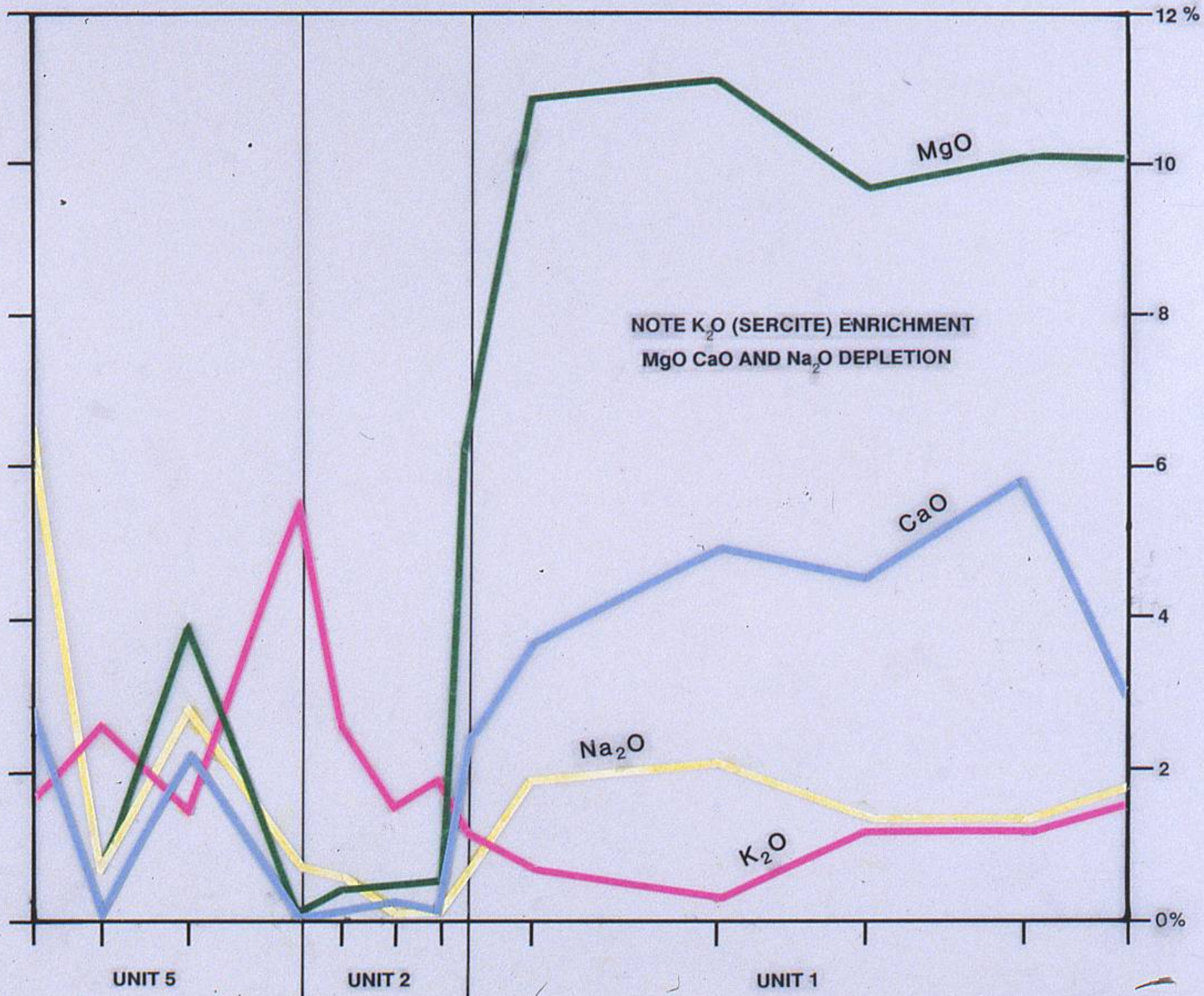


	Cu-Zn		Pb-Zn-Cu
	Cyprus	Besshi	Kuroko
Tenor	Cu-(Zn)	Cu-Zn-(Pb)	Pb-Zn-Cu-Au-Ag
Volcanic association	tholeiitic	calcalkaline	bimodal, calcalkaline
Host	basalt	basalt, terrigenous rocks	felsic pyroclastics
Tectonic setting	oceanic ridge	continental margin, back-arc	island arc
Alteration	stringer zone chloritic Fe-Mn chert	chloritic silicification Fe-Mn chert	stringer zone silicification sericitic sulphates
Examples	Anyox Chu Chua (Sunro)	Goldstream Granduc Windy Cr.	Rea Homestake Lynx Kutcho Creek Tulsequah Chief

VOLCANOGENIC MASSIVE SULPHIDE DEPOSITS - B.C.



REA - L97 LENS



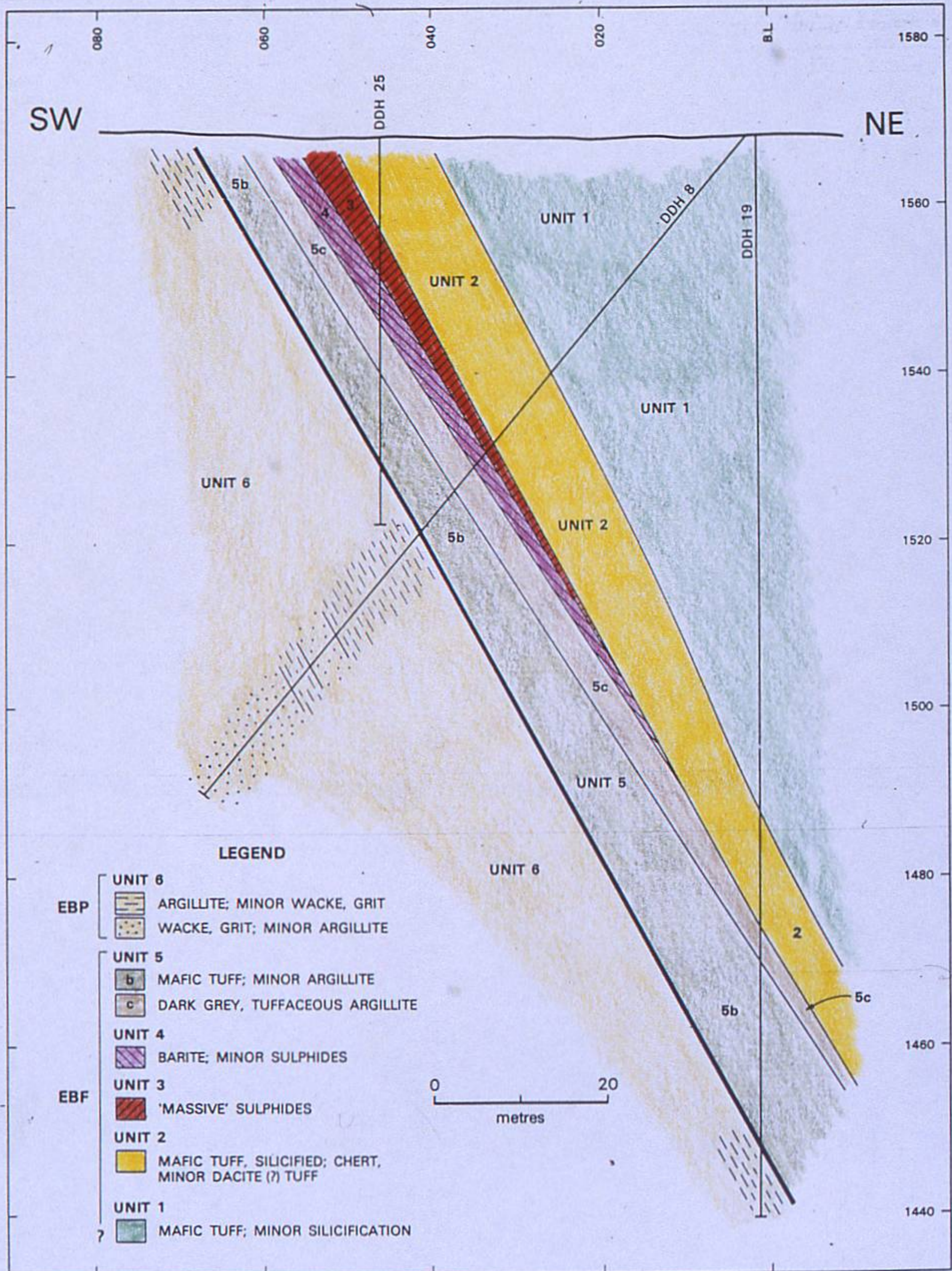
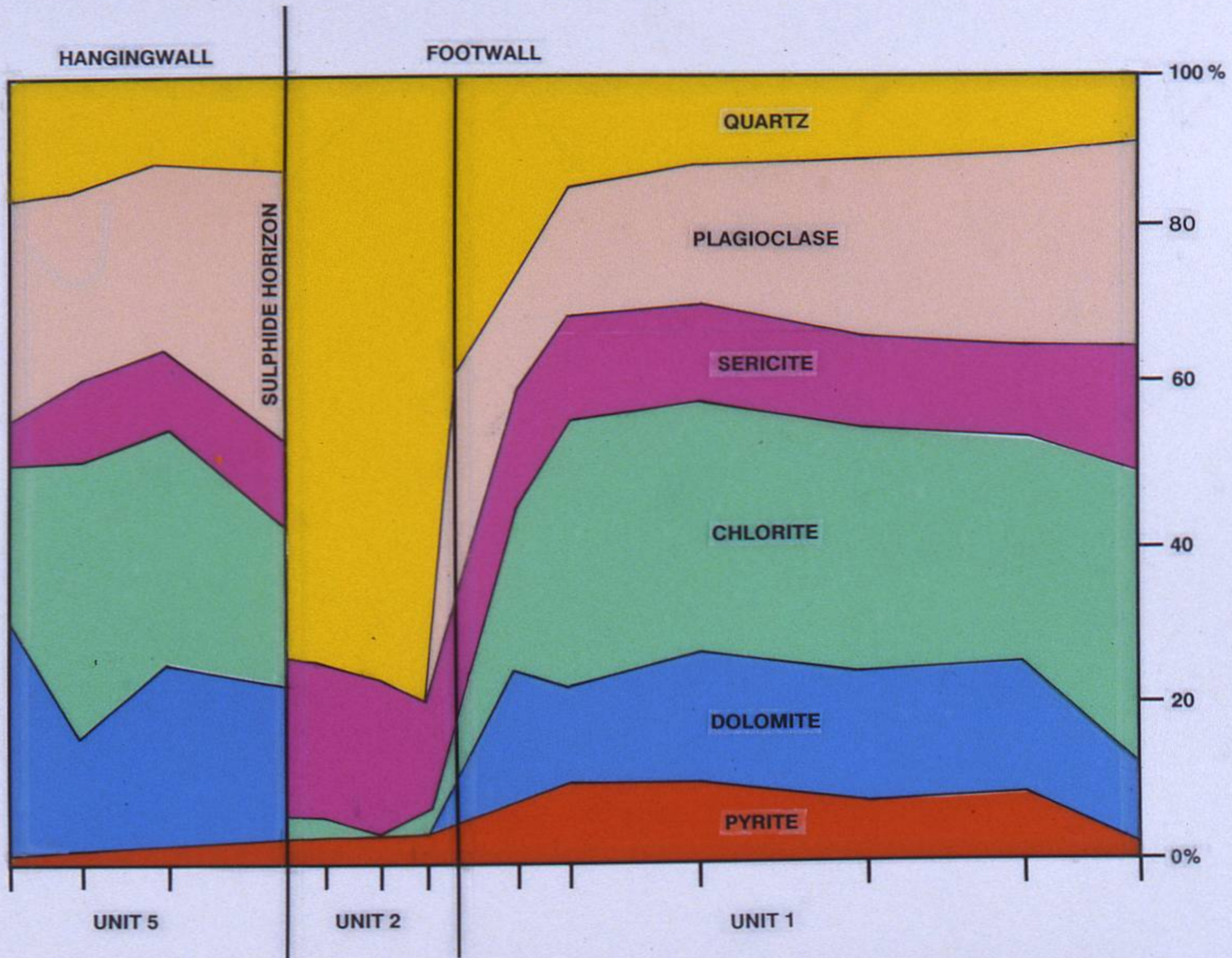
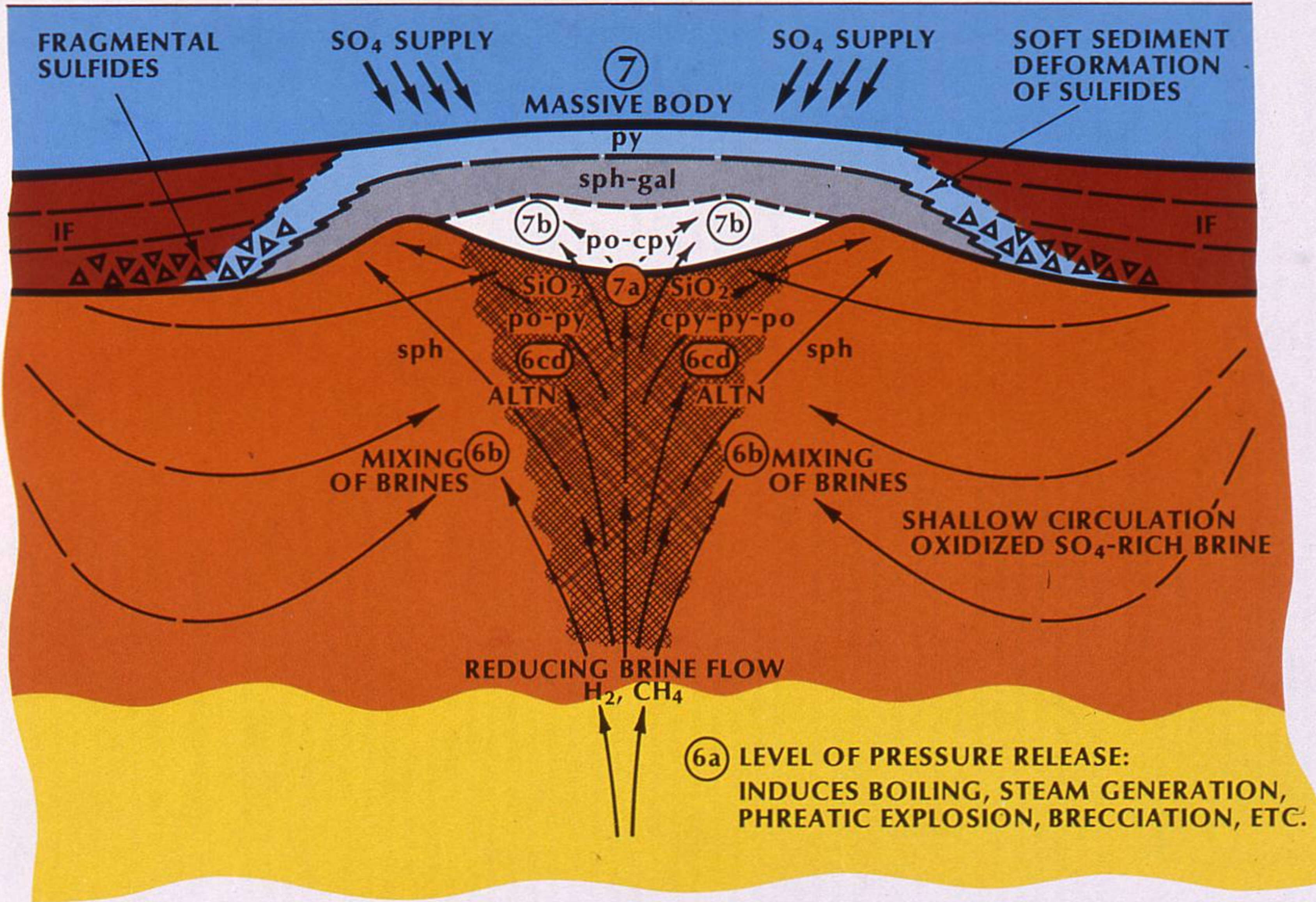


Figure 17. Cross-section through Rea massive sulphide deposit, after Höy and Goutier (1986).

REA - L97 LENS





FRAGMENTAL SULFIDES

SO₄ SUPPLY

7
MASSIVE BODY

SO₄ SUPPLY

SOFT SEDIMENT DEFORMATION OF SULFIDES

py

sph-gal

7b

po-cpy

7b

IF

IF

SiO₂

po-py

6cd

ALTN

6b
MIXING OF BRINES

SiO₂

cpy-py-po

6cd

ALTN

6b
MIXING OF BRINES

SHALLOW CIRCULATION OXIDIZED SO₄-RICH BRINE

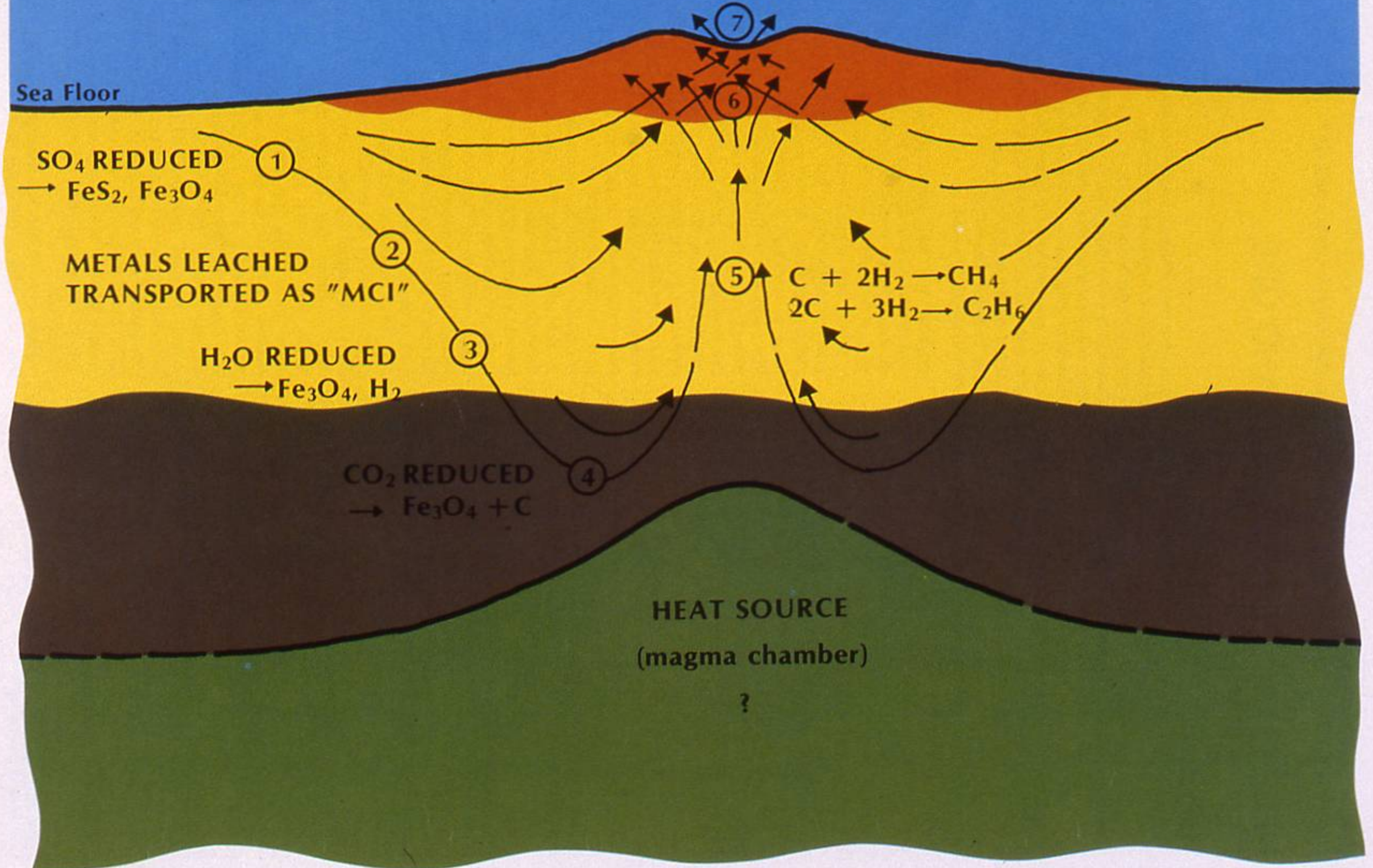
REDUCING BRINE FLOW

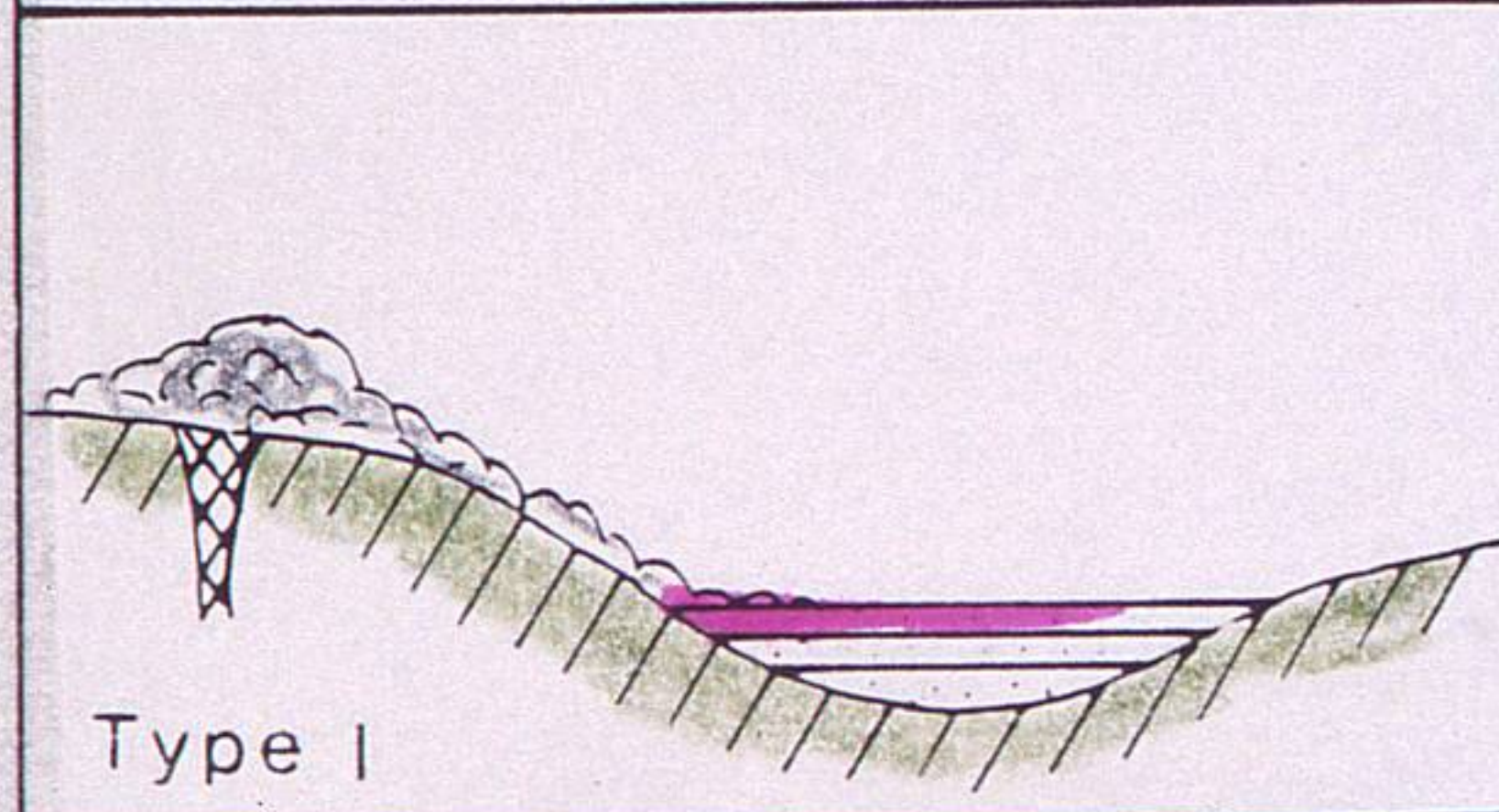
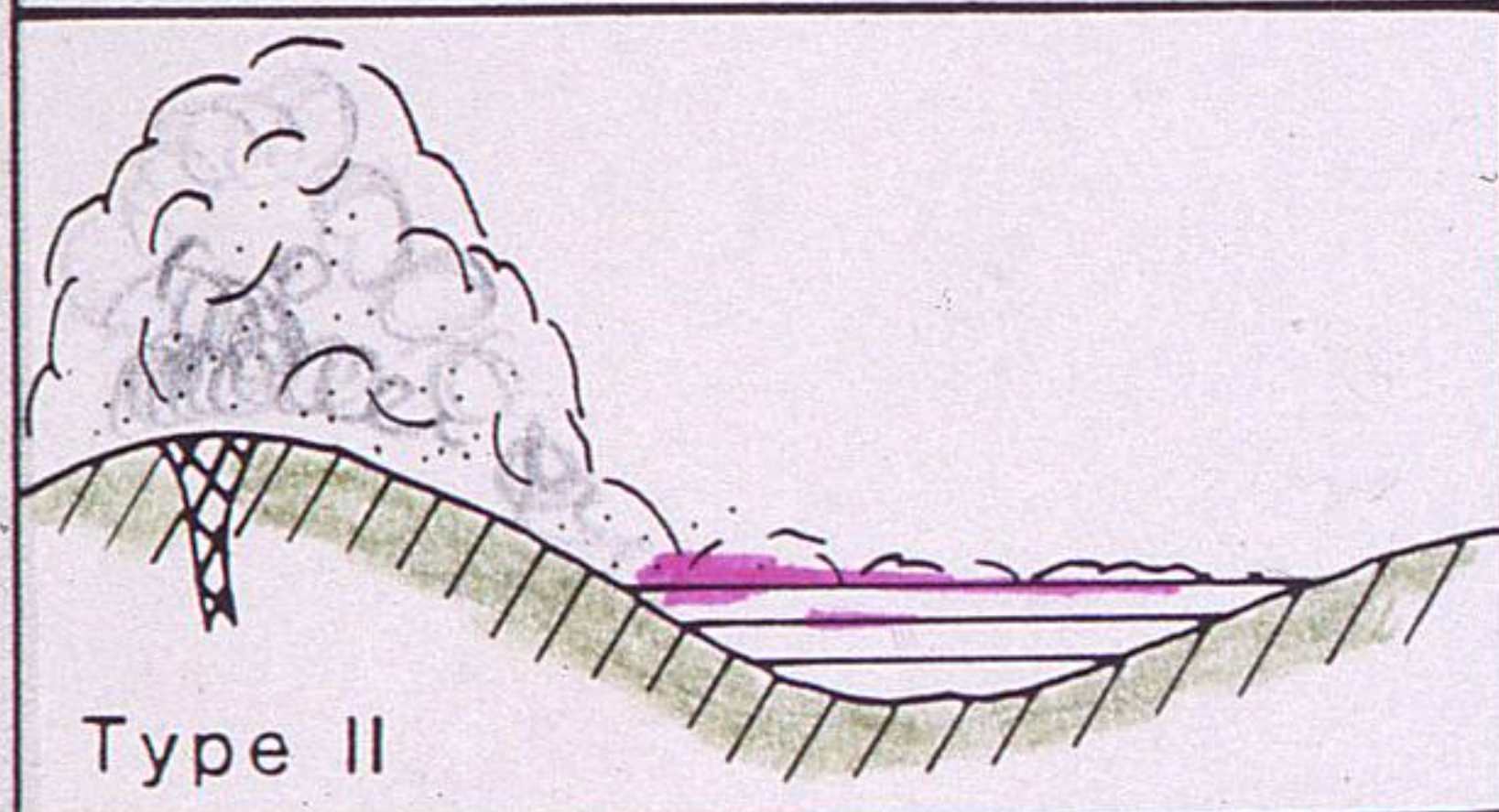
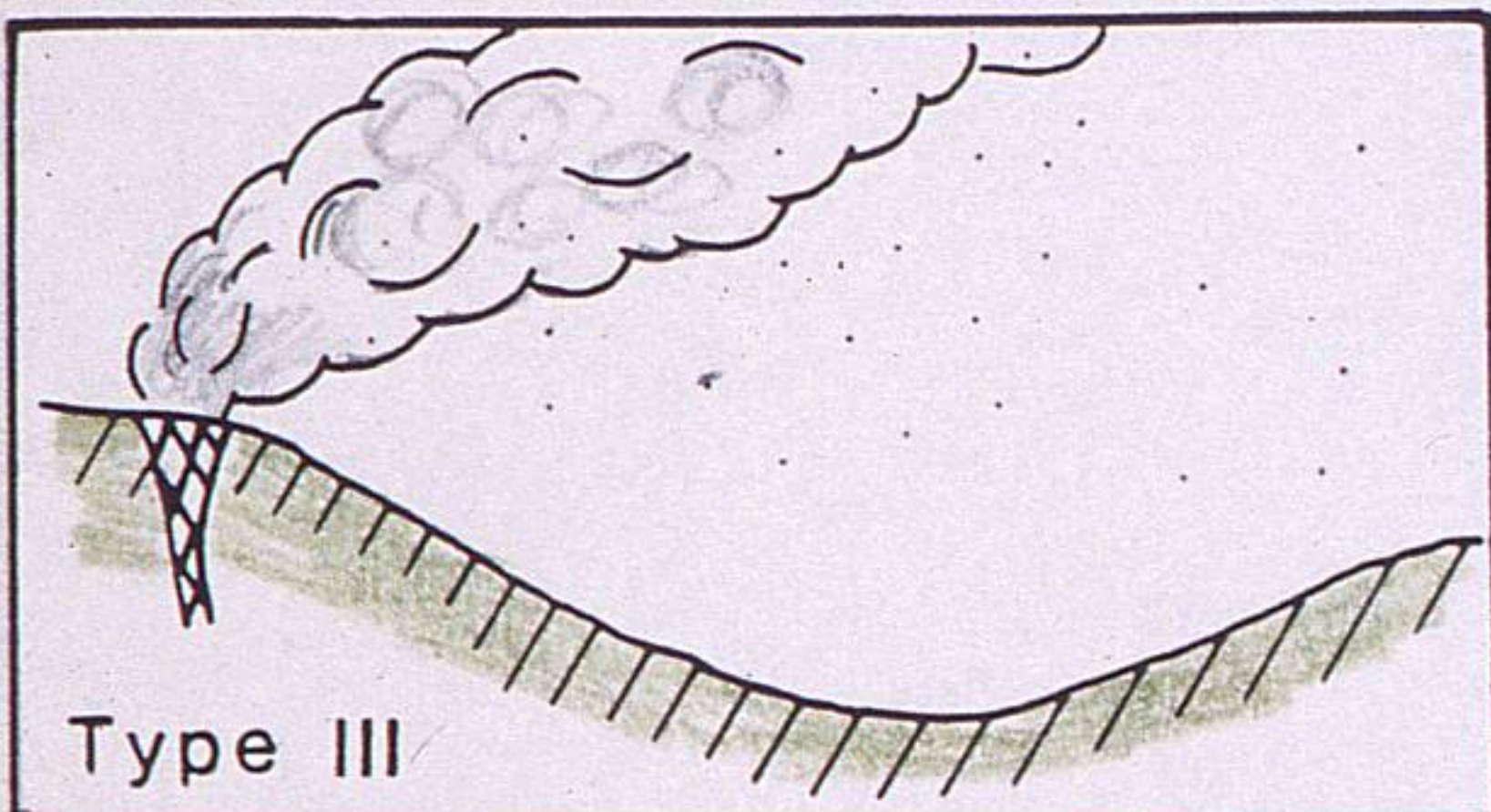
H₂, CH₄

6a LEVEL OF PRESSURE RELEASE:
INDUCES BOILING, STEAM GENERATION,
PHREATIC EXPLOSION, BRECCIATION, ETC.

Sea Level

Sea Floor

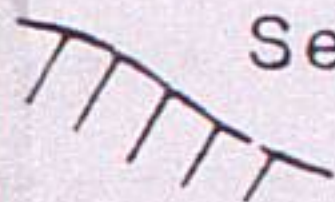




Hydrothermal vent



Hydrothermal plume



Sea floor



Brine pool



Sulphide nucleation zone

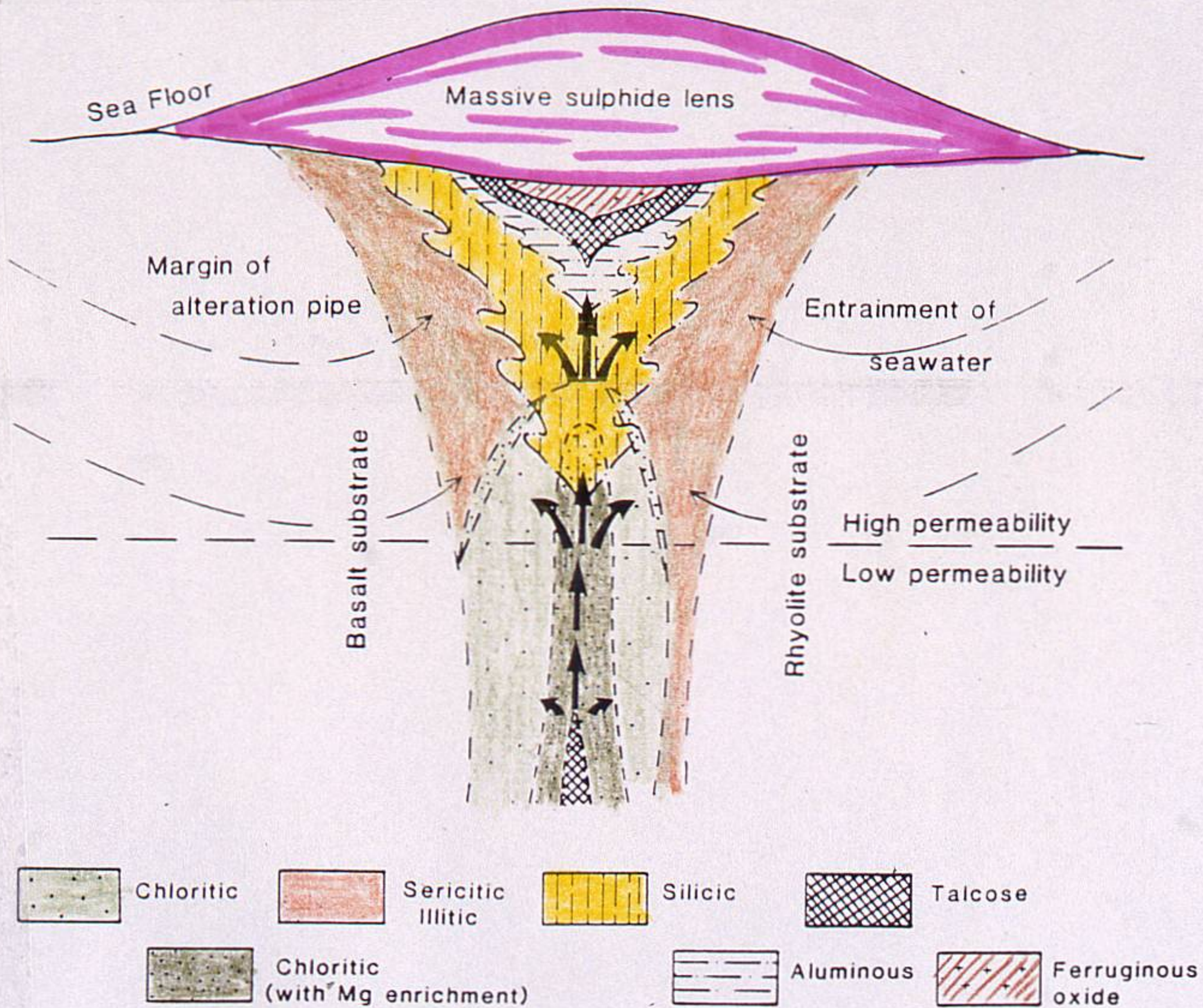


Figure 8 Composite representation of the various alteration assemblages that have been reported for alteration pipes of VMS deposits. See text for explanation and discussion.

MASSIVE SULPHIDE LENS

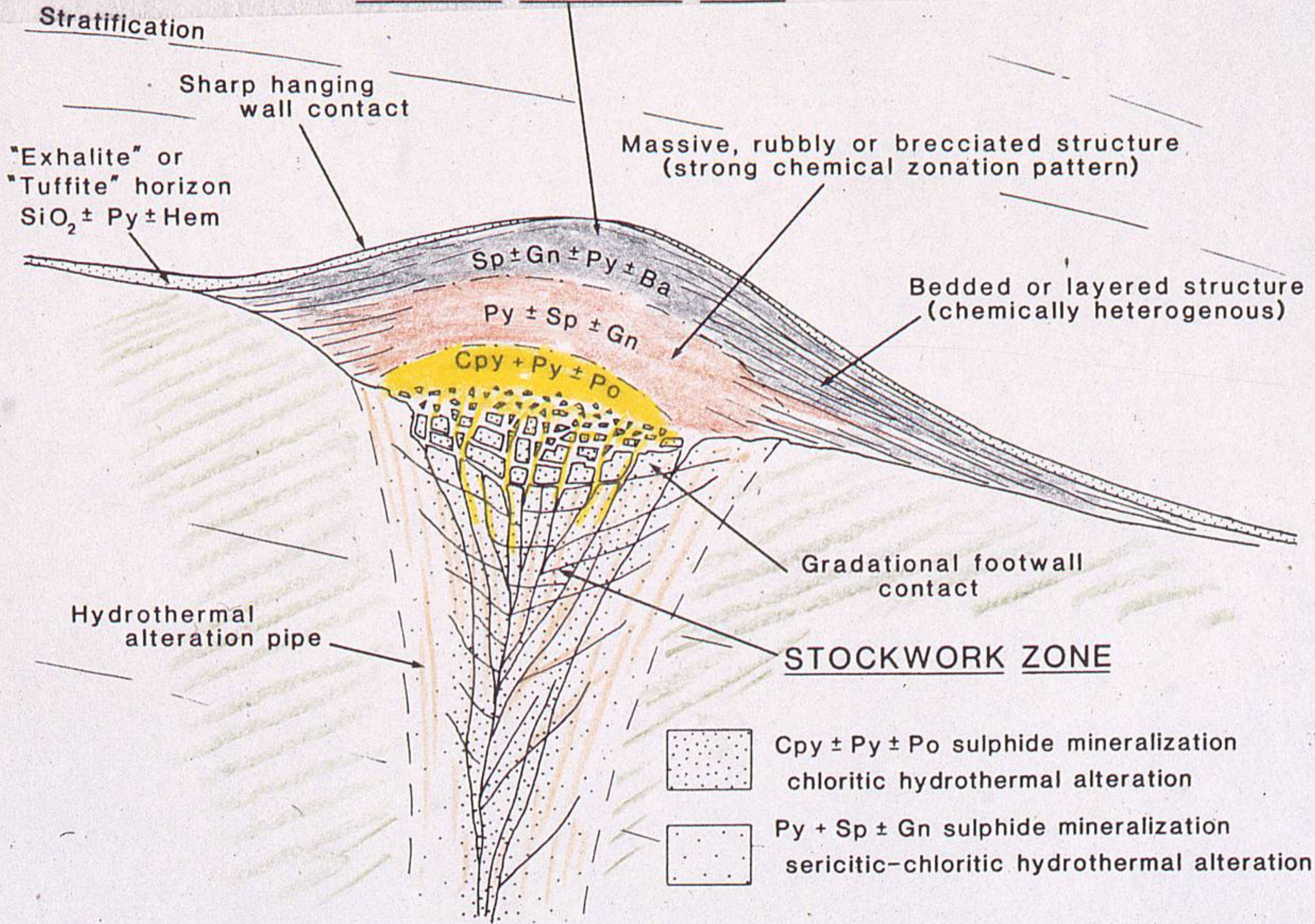


Figure 2 Essential characteristics of an idealized volcanogenic massive sulphide deposit.

Sea Level

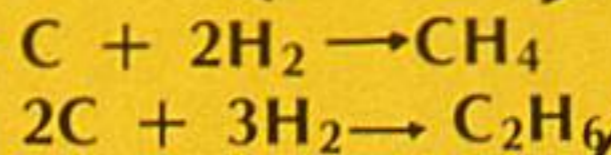
Sea Floor

SO₄ REDUCED
→ FeS₂, Fe₃O₄

METALS LEACHED
TRANSPORTED AS "MCl"

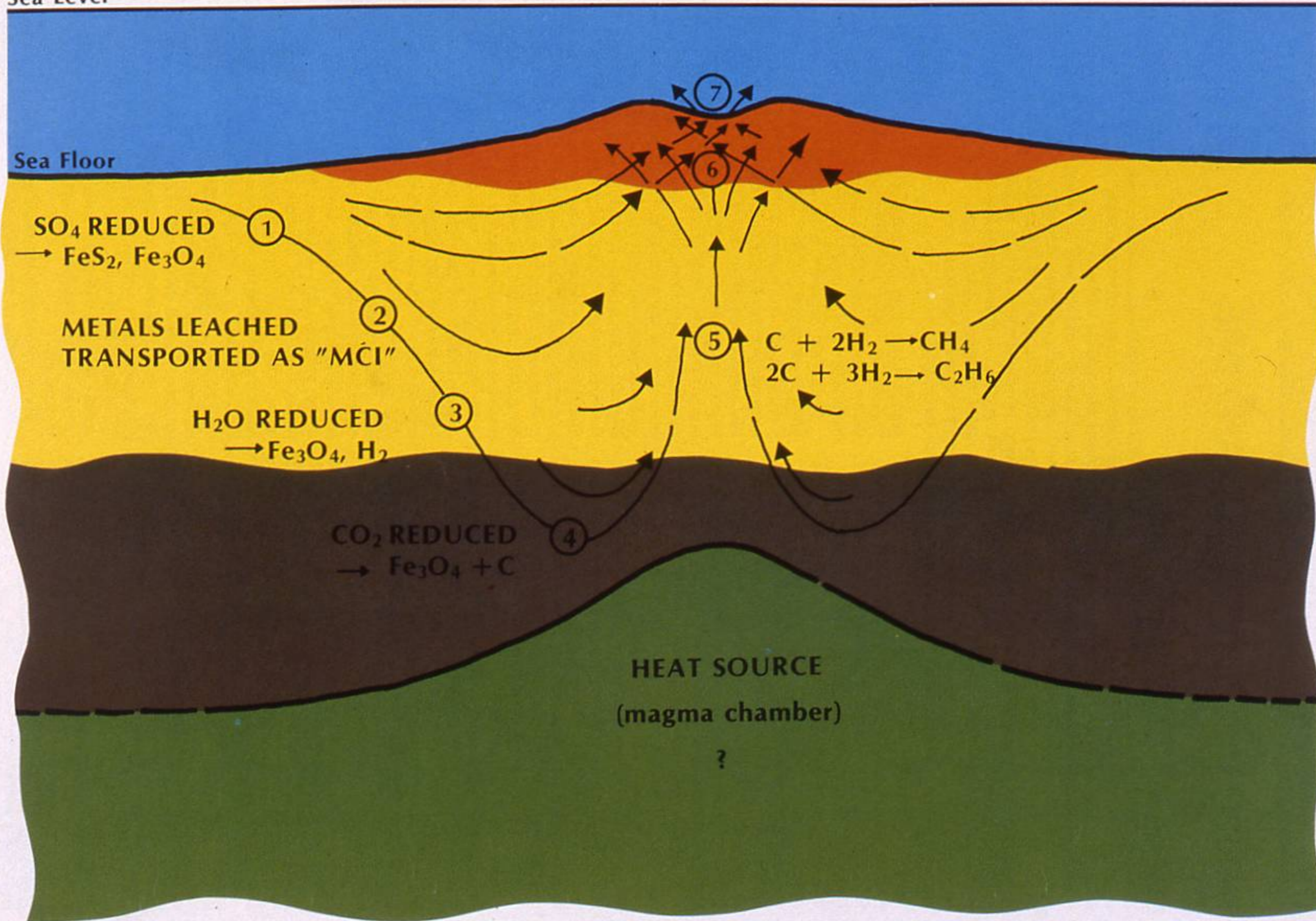
H₂O REDUCED
→ Fe₃O₄, H₂

CO₂ REDUCED
→ Fe₃O₄ + C

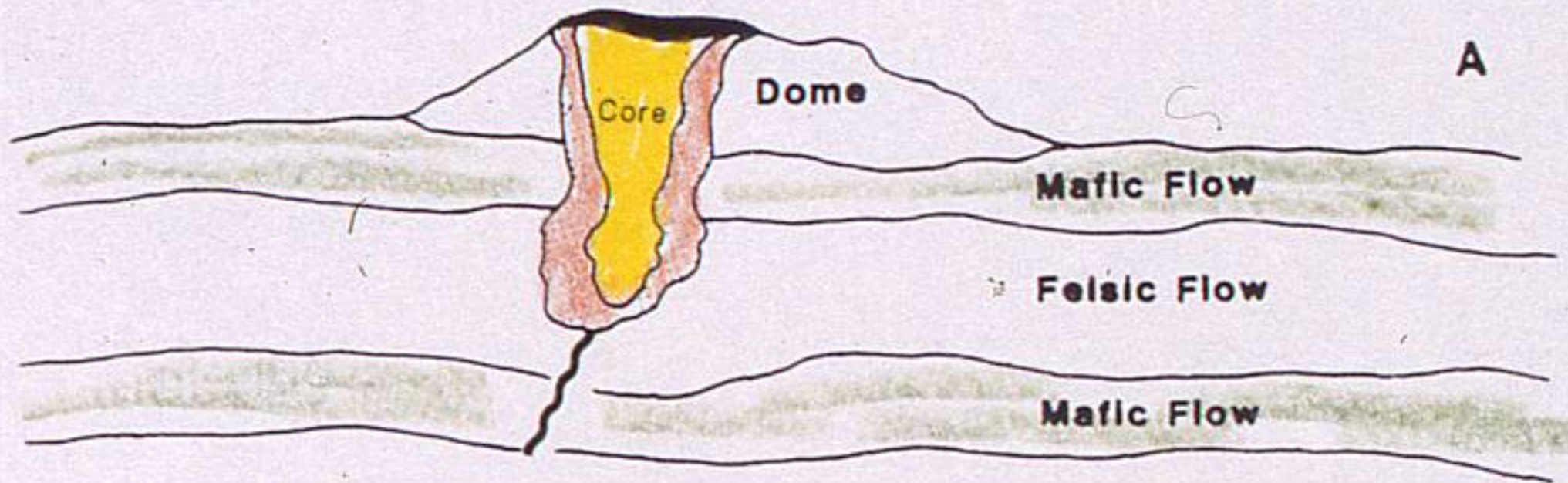


HEAT SOURCE
(magma chamber)

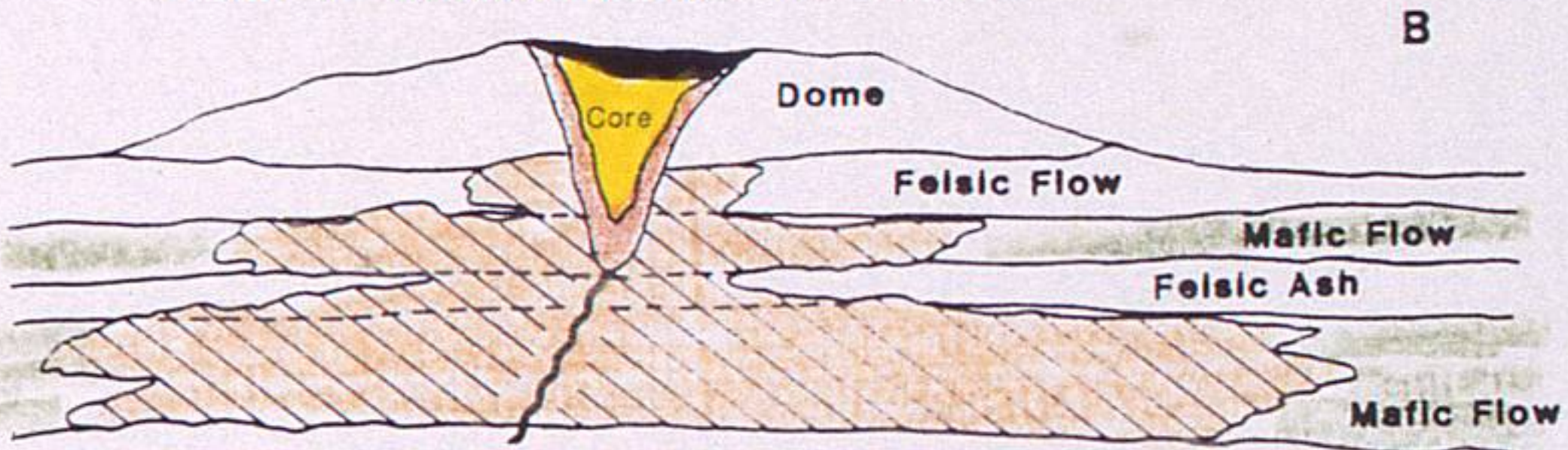
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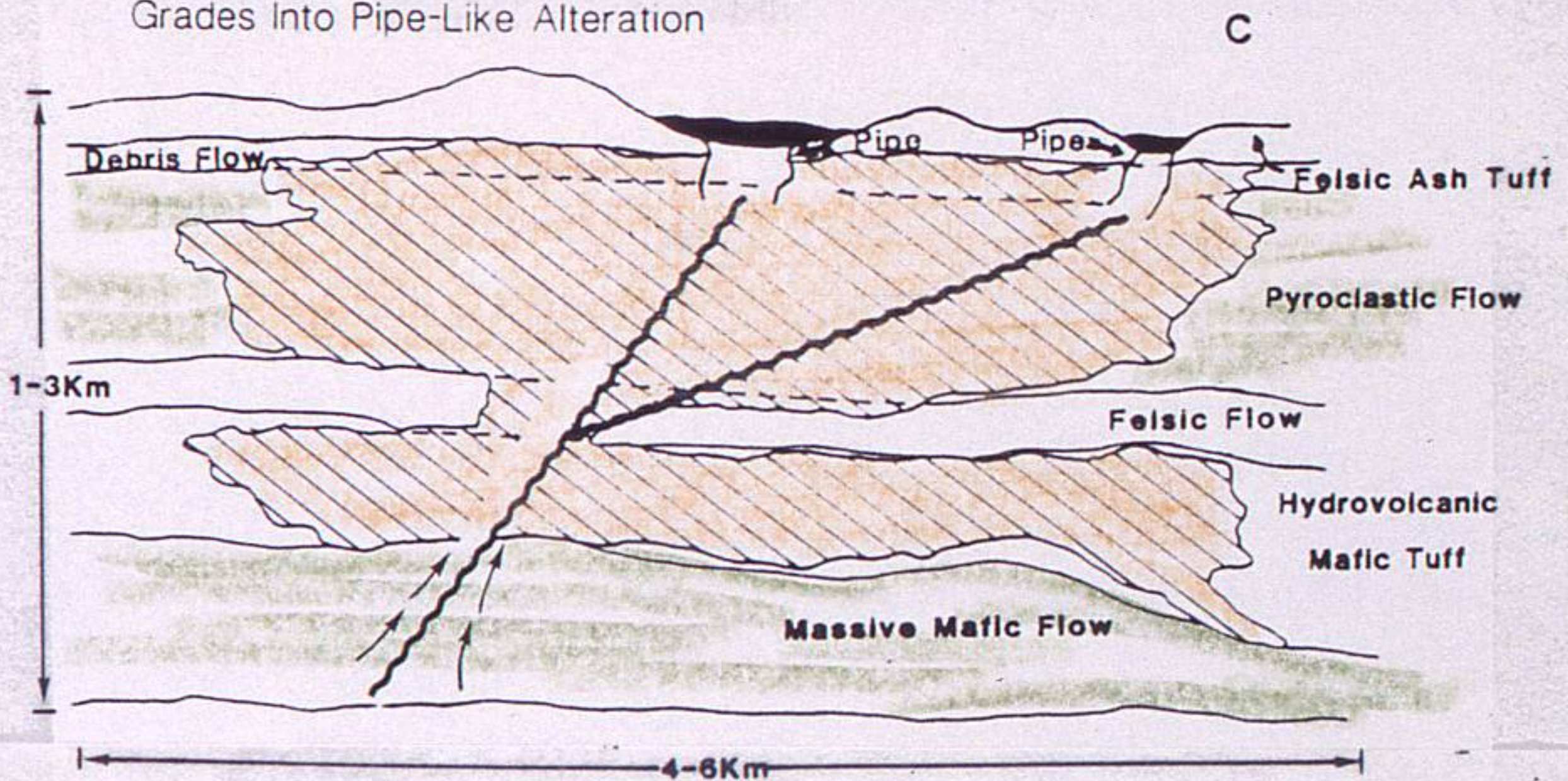
Noranda-Type
Pipe-Like Alteration



Noranda-Type
Semi-Conformable Alteration
X-Cut or Overlain by Pipe-Like Alteration



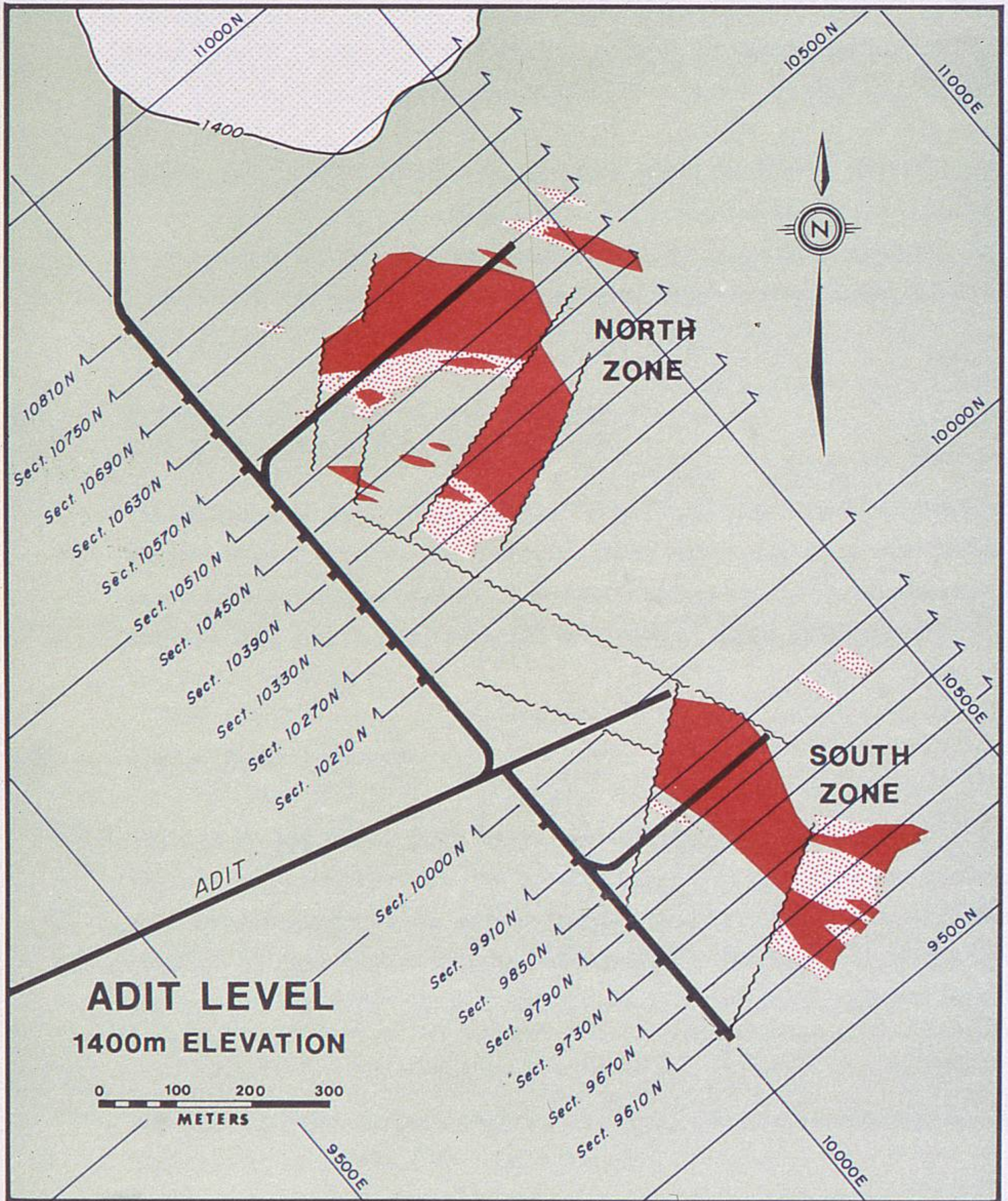
Mattabi-Type
Semi-Conformable Alteration
Grades Into Pipe-Like Alteration



DEPOSIT OUTLINE

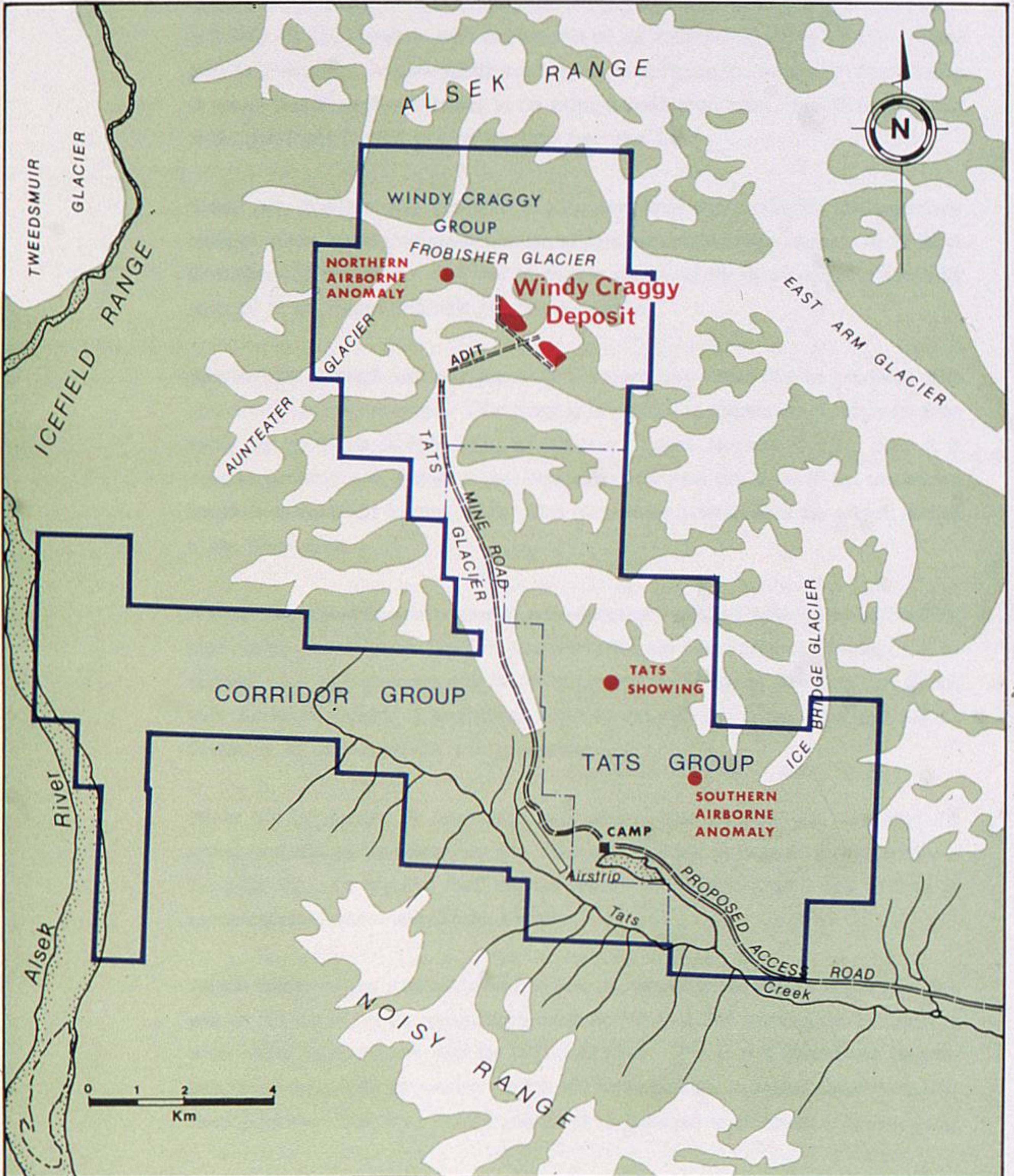
WINDY CRAGGY DEPOSIT

NOVEMBER, 1989



PROPERTY MAP

WINDY CRAGGY DEPOSIT



TECTONIC ENVIRONMENTS MASSIVE SULPHIDE DEPOSITS

