Igneous Rocks and Processes

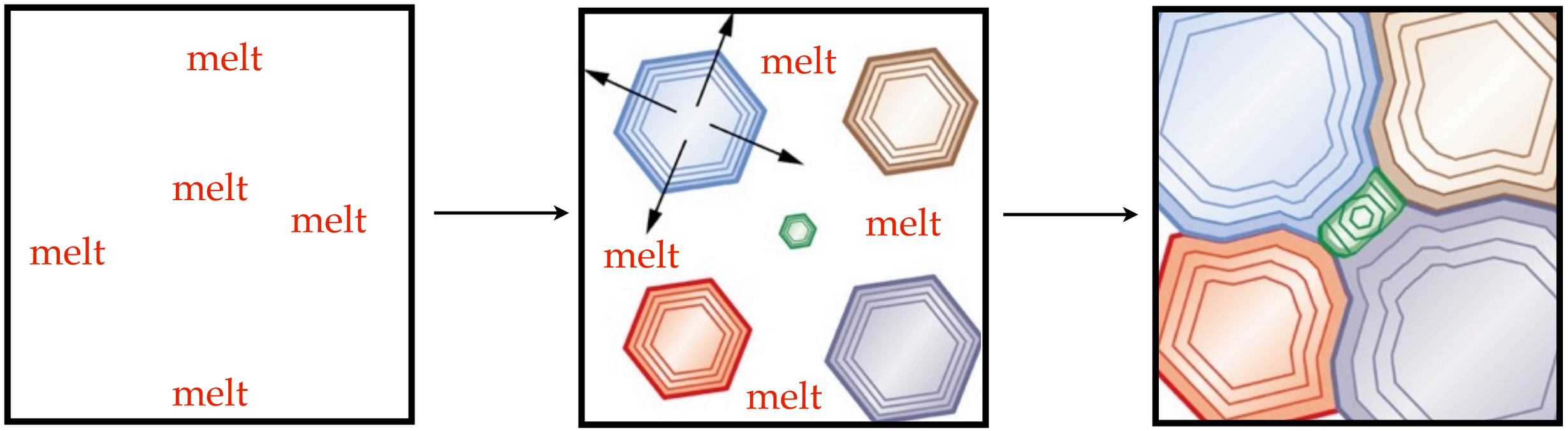
Tierra del Fuego, South America

If we were to freeze the magma at each of these three times the resulting textures would be

Cooling →

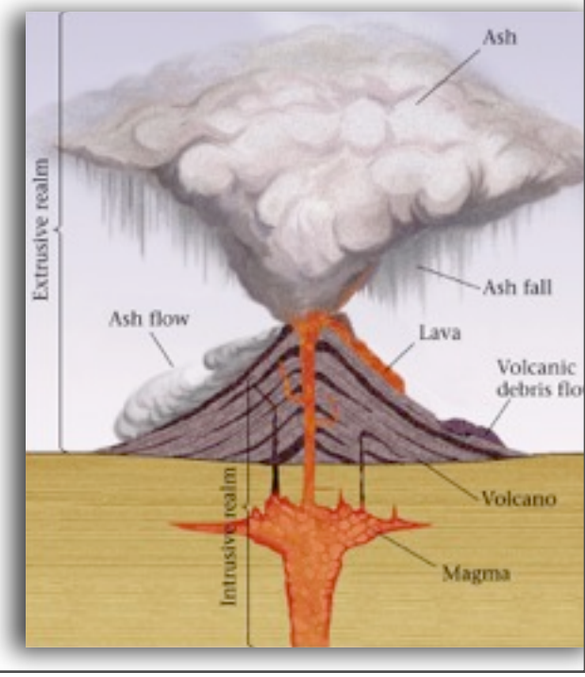
1300 C

600 C



Time 1 Time 2 Time 3

a) phaneritic, aphanitic, porphyritic
b) porphyritic, phaneritic, aphanitic
c) aphanitic, porphyritic, phaneritic
d) porphyritic, aphanitic, phaneritic



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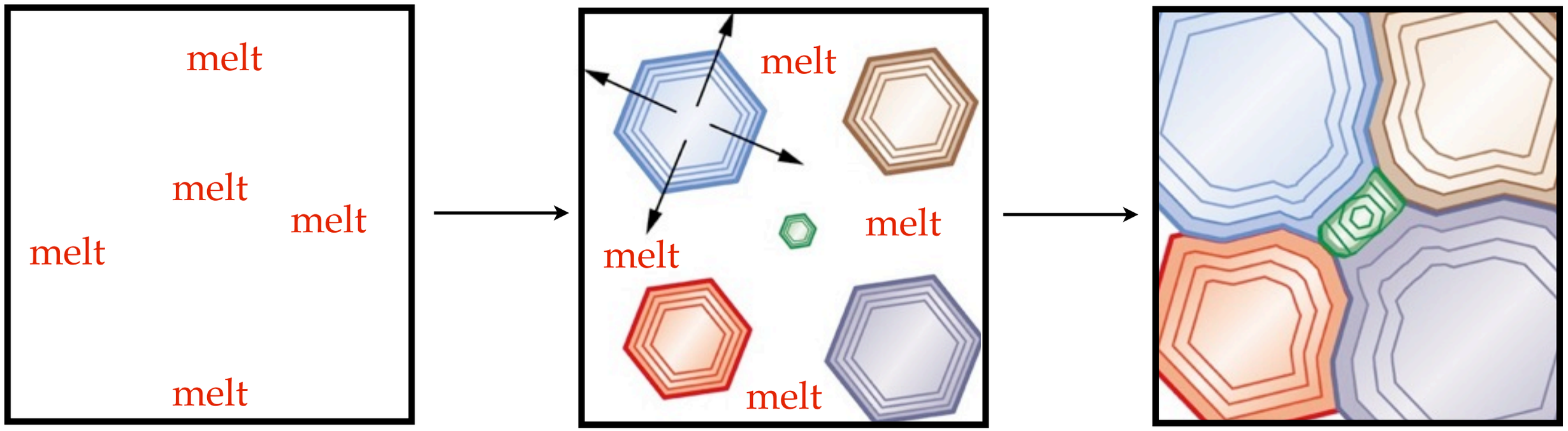

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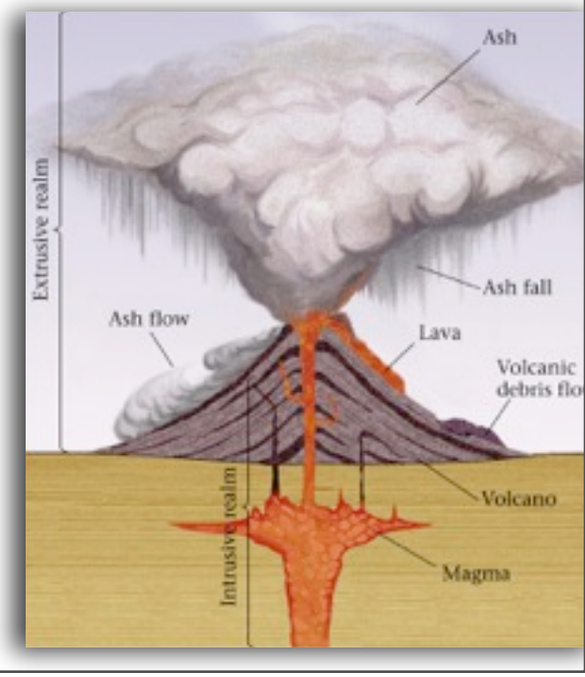

From left to right the three textures shown below are_____

a) phaneritic, aphanitic, porphyritic
b) porphyritic, phaneritic, aphanitic
c) aphanitic, porphyritic, phaneritic
d) porphyritic, aphanitic, phaneritic

From left to right the three textures shown below are_____

a) phaneritic, aphanitic, porphyritic
b) porphyritic, phaneritic, aphanitic
c) aphanitic, porphyritic, phaneritic
d) porphyritic, aphanitic, phaneritic

Now that you know the texture of this igneous rock, what else would you like to know in order to determine its Rock name?

a) What plate boundary it formed at
b) What the black minerals are
c) What the gray minerals are
d) How old it is.
e) None of the above

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a) What plate boundary it formed at
b) What the black minerals are
c) What the gray minerals are
d) How old it is.
e) None of the above

The black minerals have two directions of cleavage at that are not at 90 degrees with respect to each other. What is the name of this rock?

a) Andesite
b) Granite
c) Diorite
d) Rhyolite
e) Gabbro

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a) Andesite
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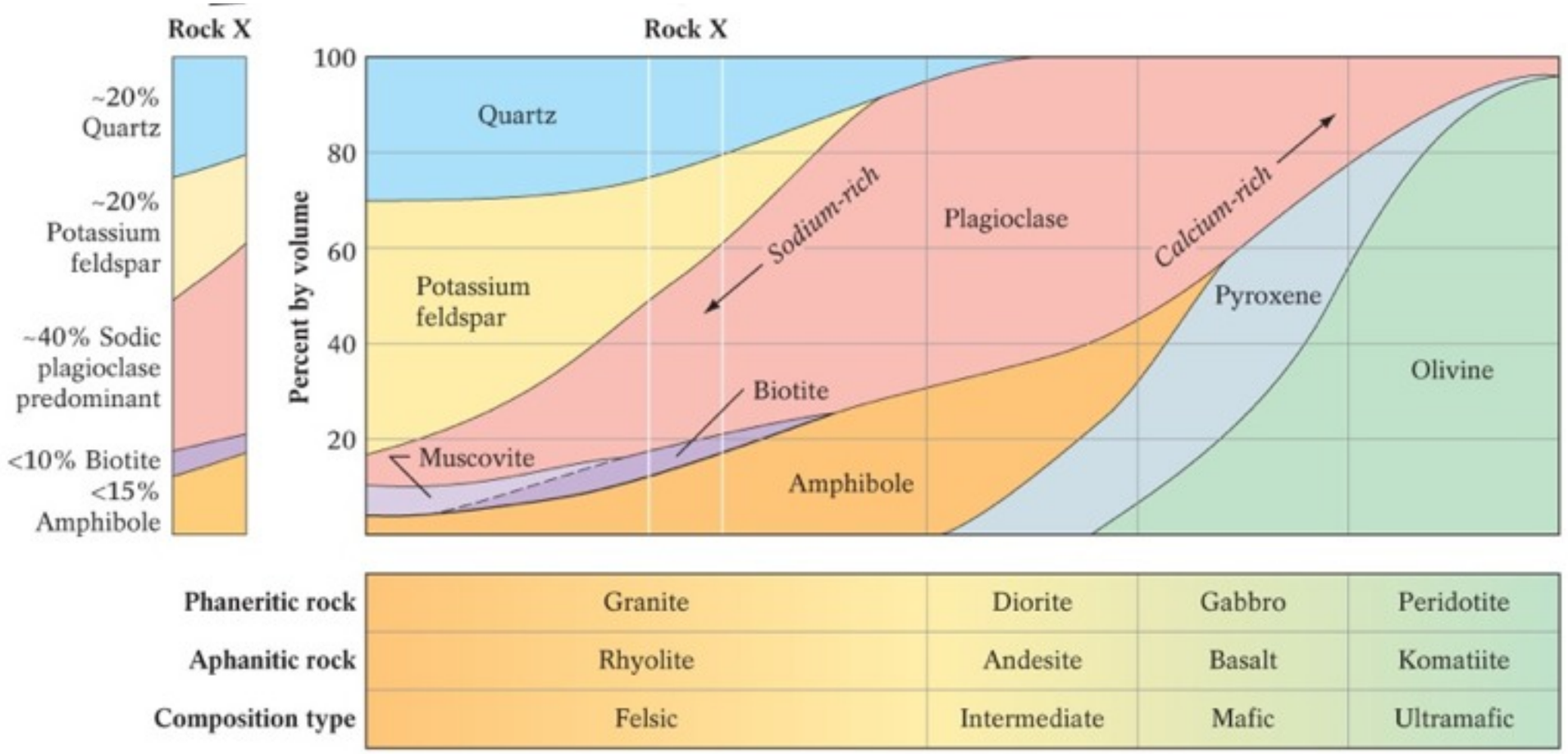
d) Rhyolite
e) Gabbro

What percent of the minerals in your andesite would you expect to be Hornblende(amphibole)?



Phaneritic rock	Granite	Diorite	Gabbro	Peridotite
Aphanitic rock	Rhyolite	Andesite	Basalt	Komatiite
Composition type	Felsic	Intermediate	Mafic	Ultramafic

a) 0-10
b) 0-20
c) 10-30
d) 20-60

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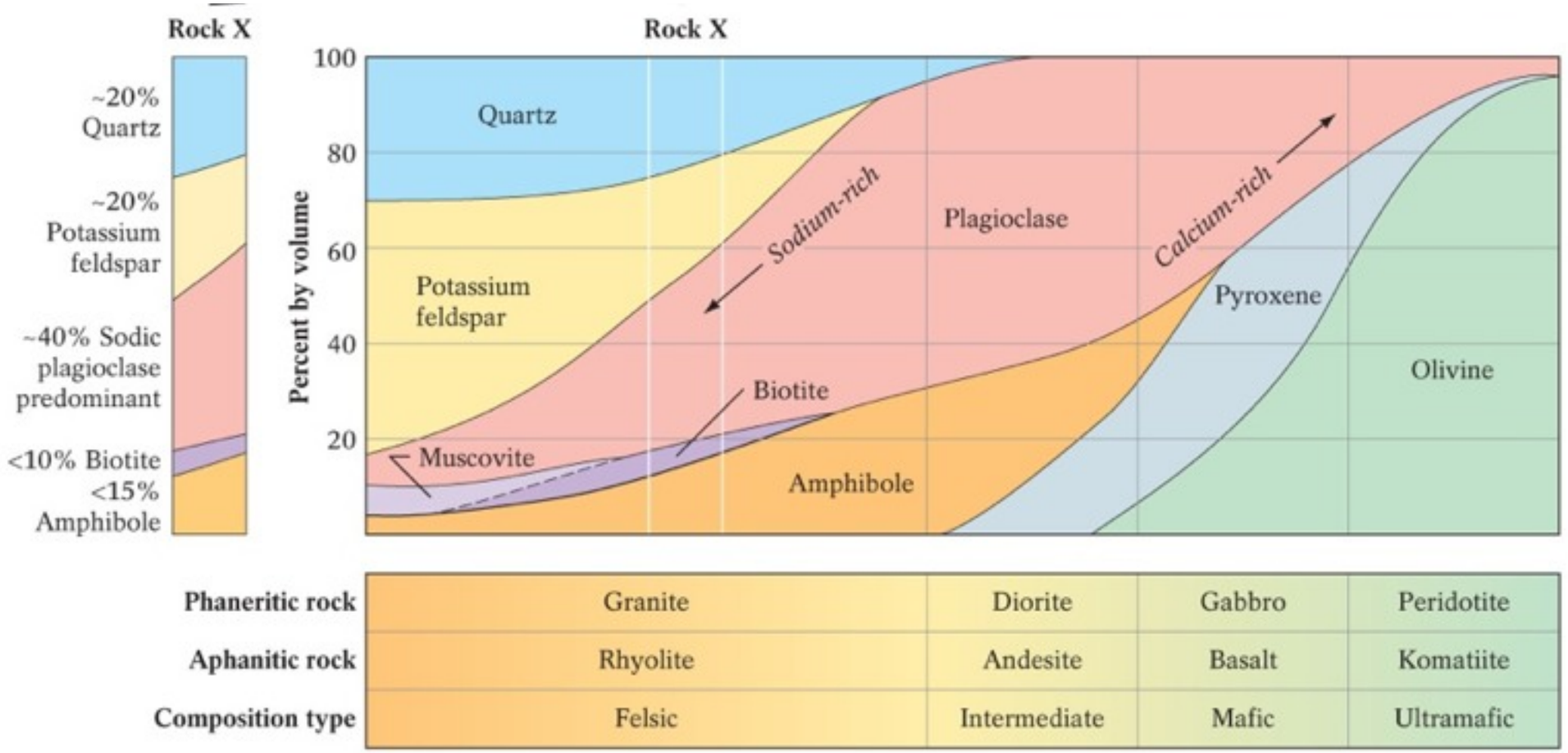

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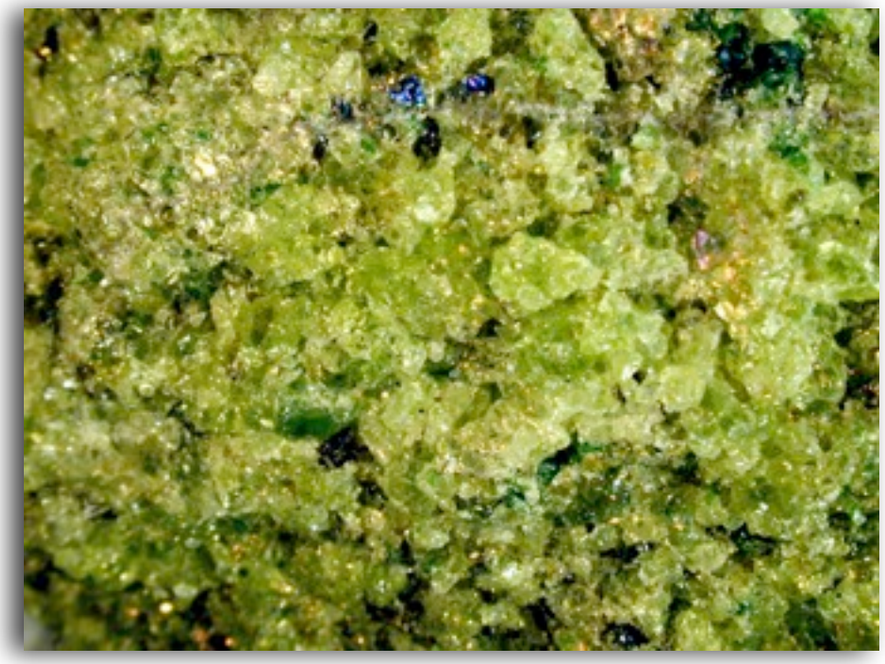
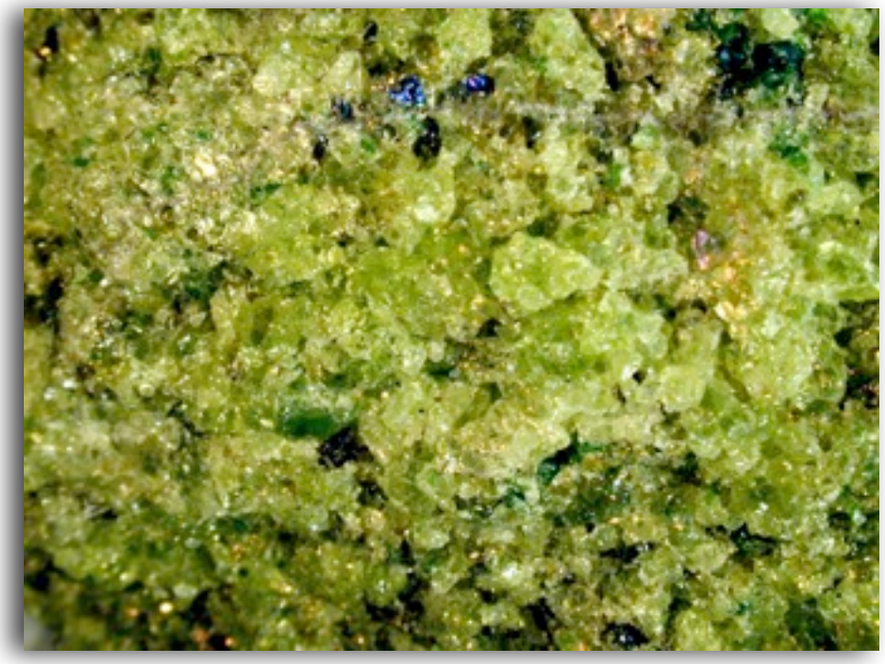


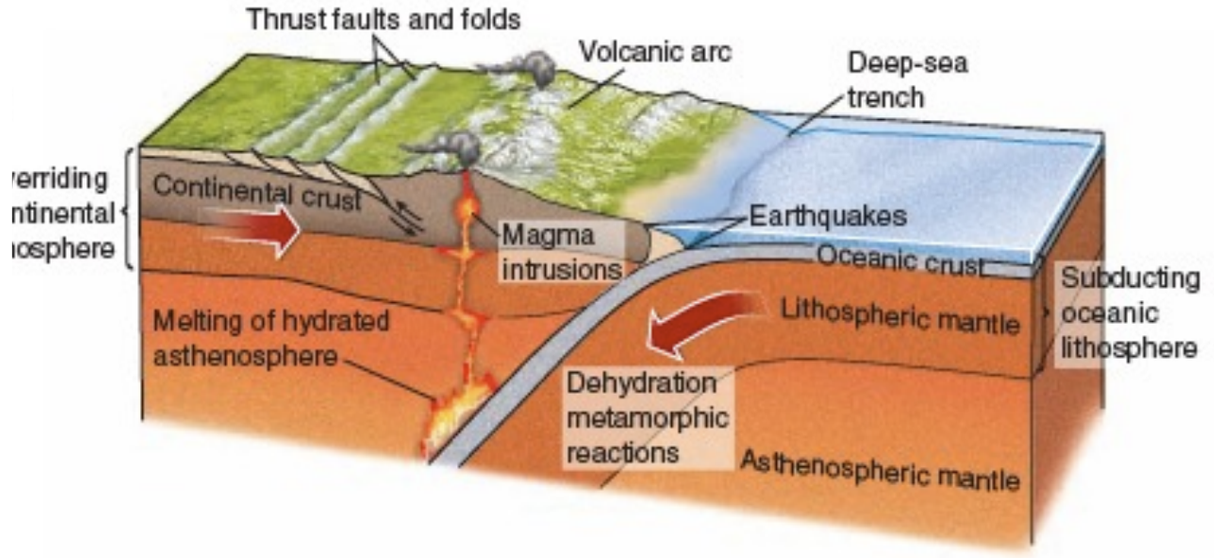
Ultramafic Mantle
Peridotite (<40% silica)

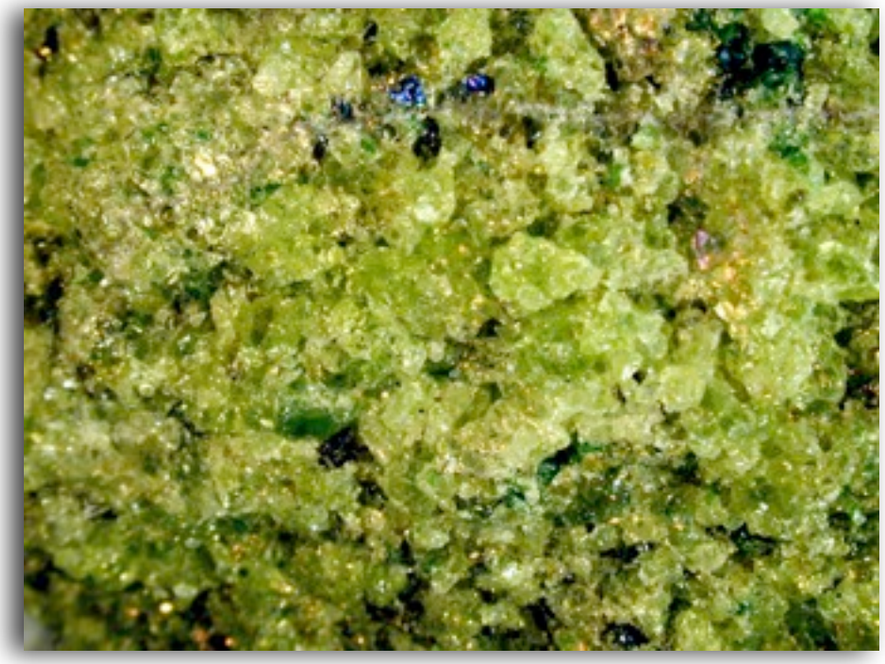


Ultramafic Mantle Peridotite (<40% silica)

Partial melting

< 10% asthenospheric melting occurs at plate boundaries





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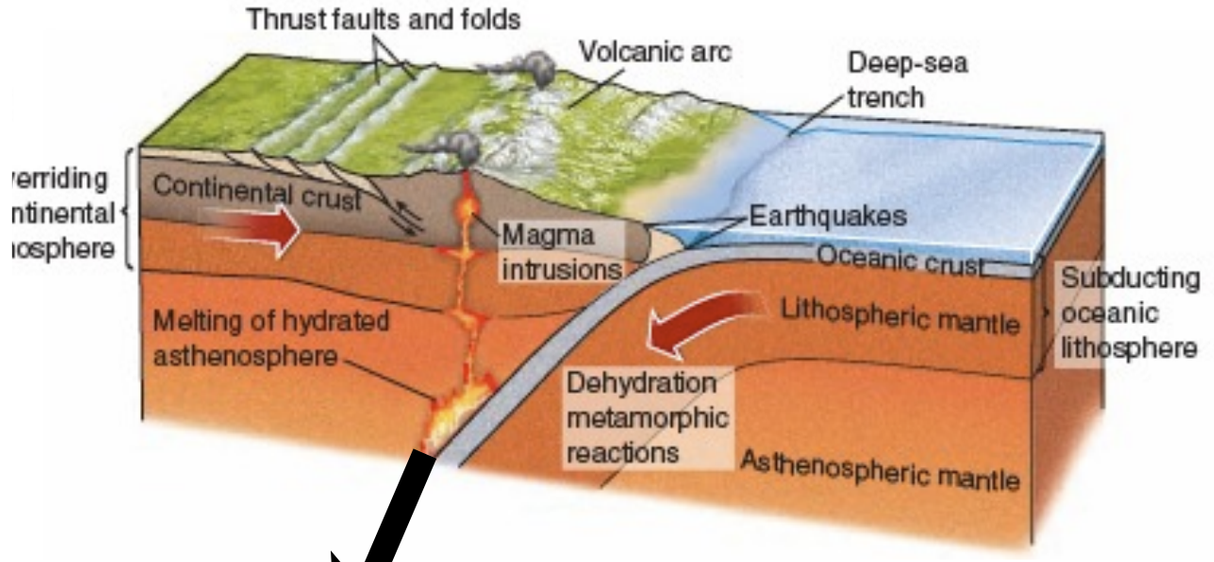


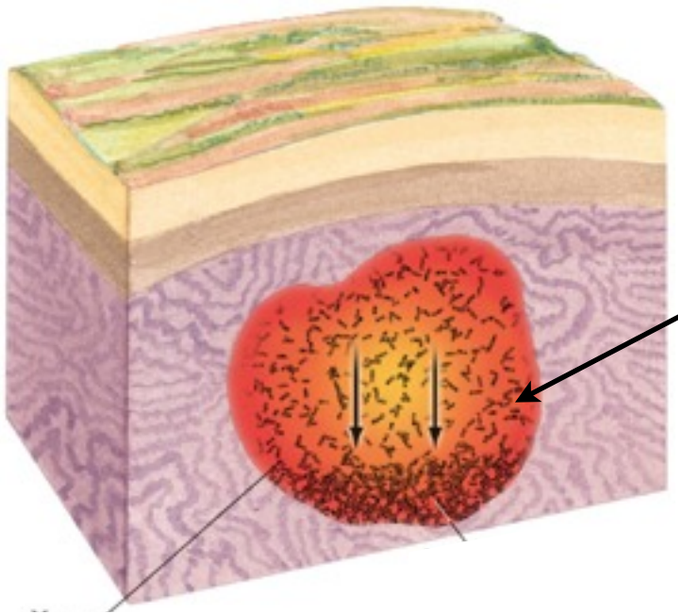
The Magma Produced is Mafic in Composition (Basaltic) and contains 45-55% silica

No Crystals

Magma Differentiation

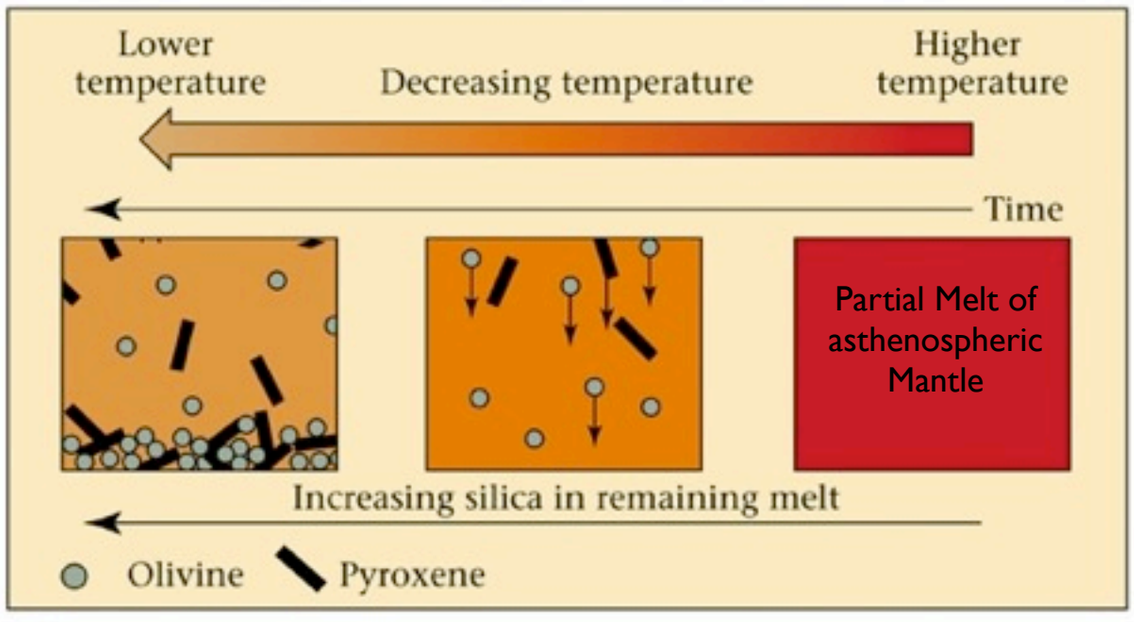
by

Fractional Crystallization



Magma Chamber

Increasing Silica



(b)

Temp. | Comp.

Ultra-Mafic

Partial melt of Asthenospheric Mantle Peridotite

No Crystals

1300

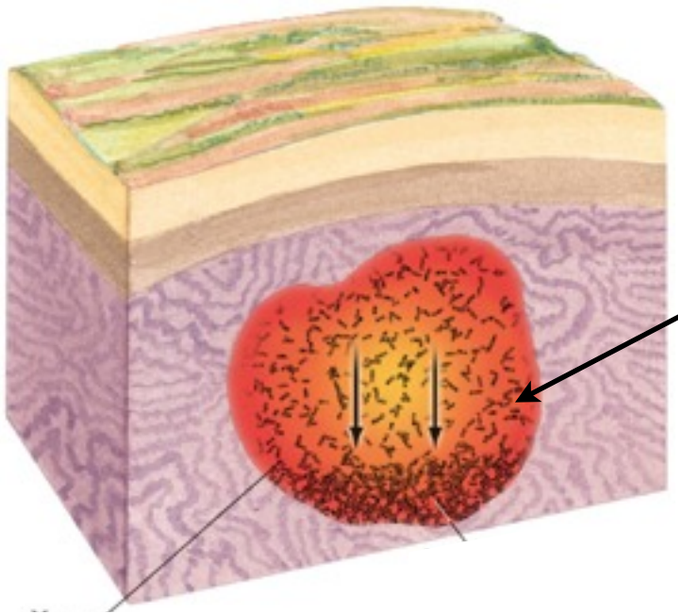
900

600

Magma Differentiation

by

Fractional Crystallization



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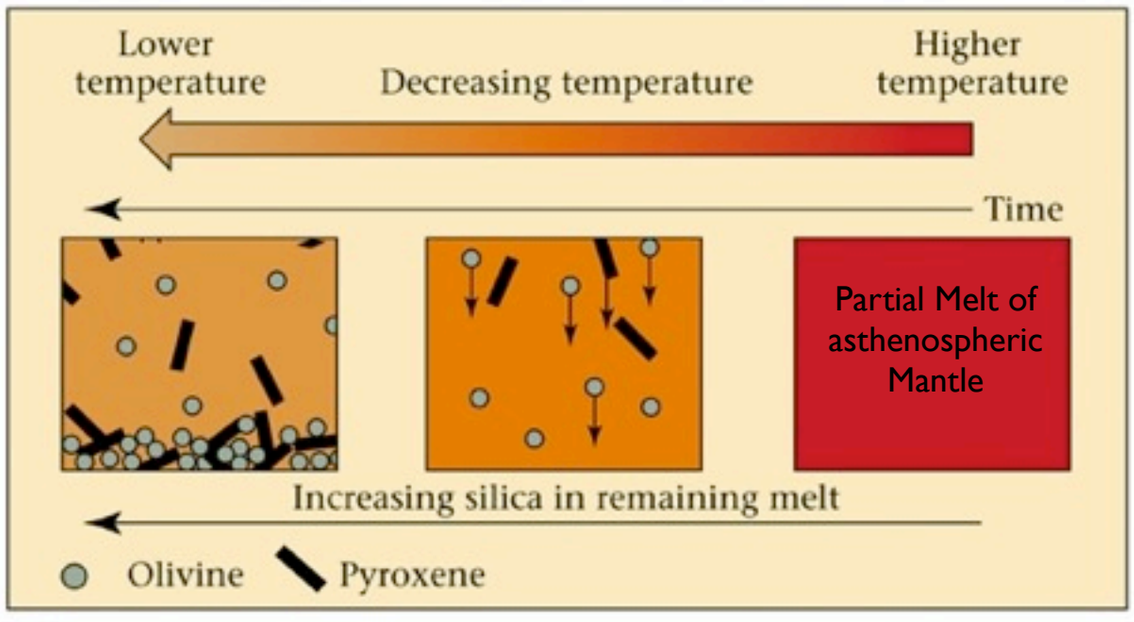

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Ultra-Mafic

1300

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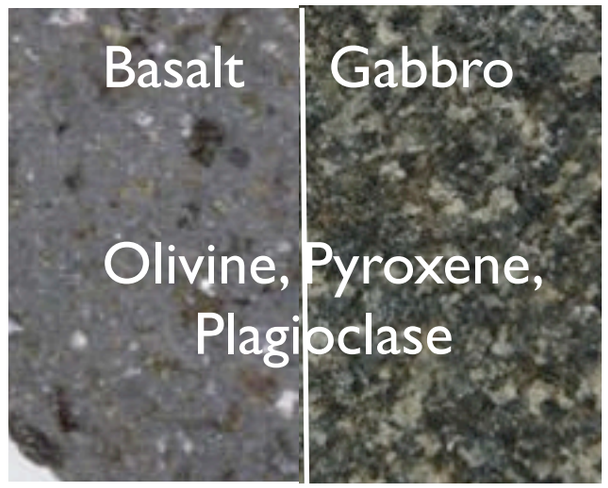
900

600

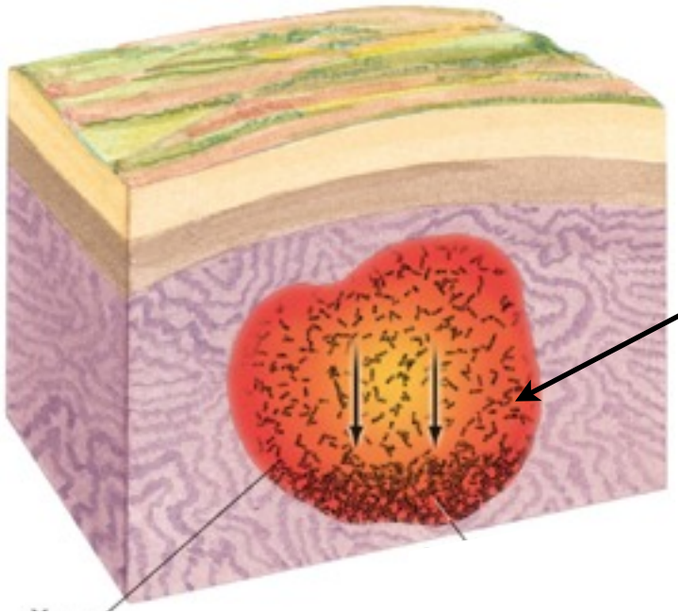
Partial melt of Asthenospheric Mantle Peridotite

No Crystals



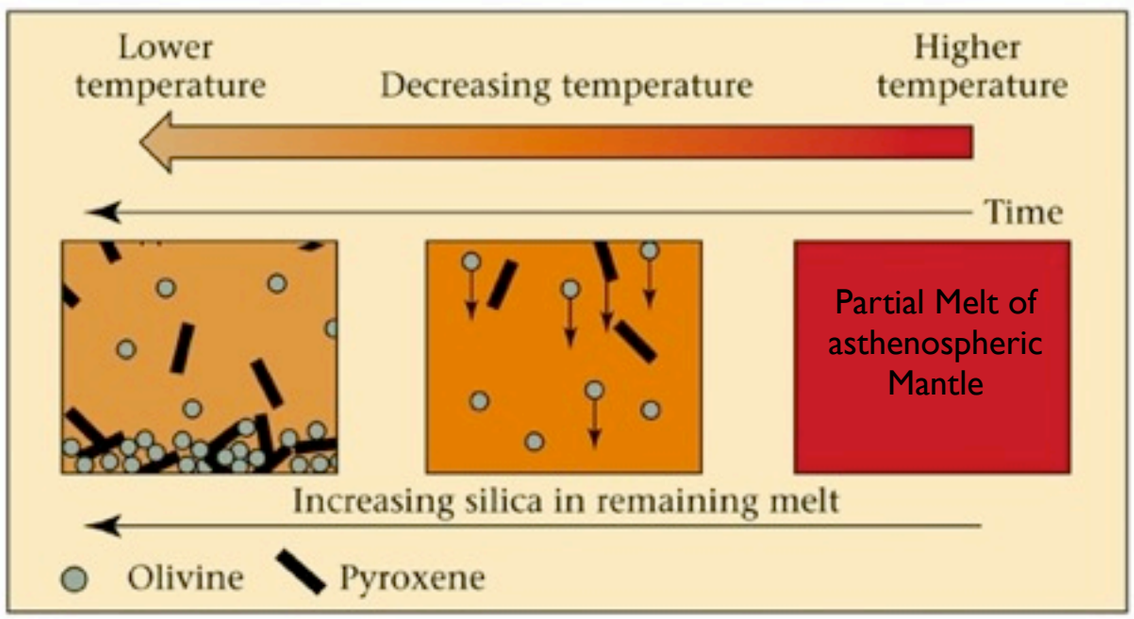
Magma Differentiation

by
Fractional Crystallization



Magma Chamber

Increasing Silica

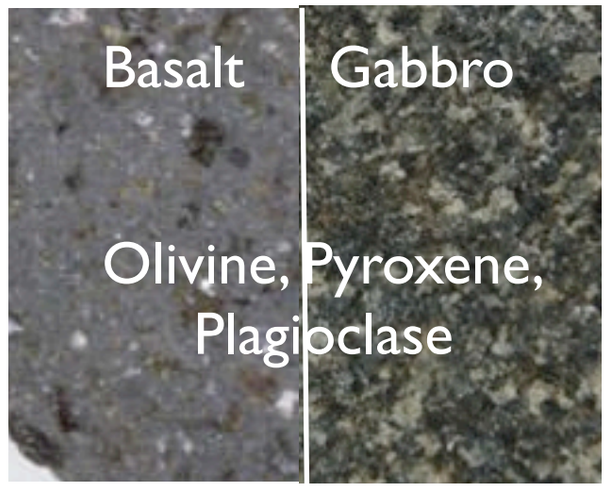


(b)

Temp.	Comp.
	Ultra-Mafic
1300	
	Mafic
900	
	Interm.
600	

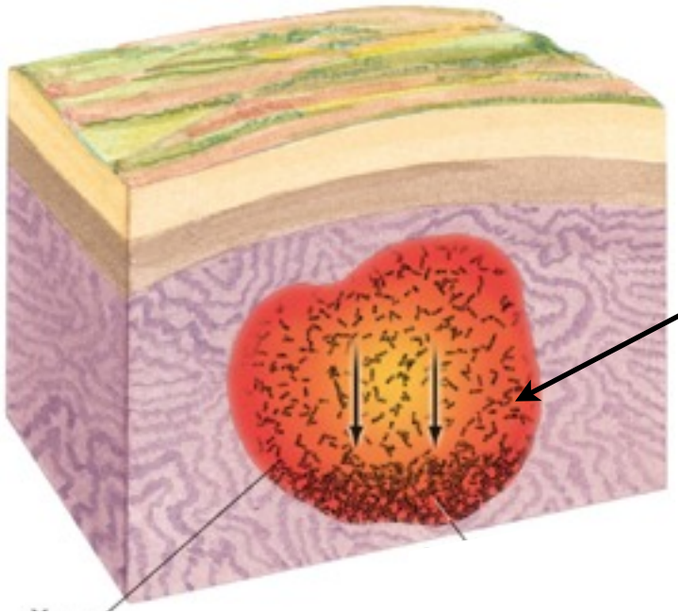
Partial melt of Asthenospheric Mantle Peridotite

No Crystals



Magma Differentiation

by
Fractional Crystallization



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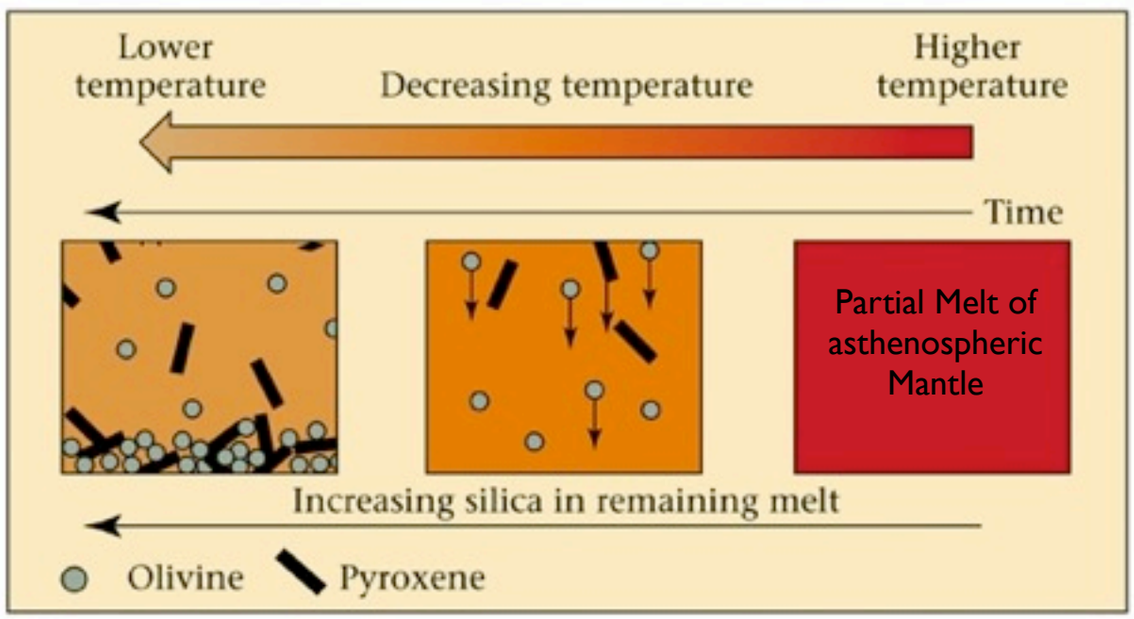
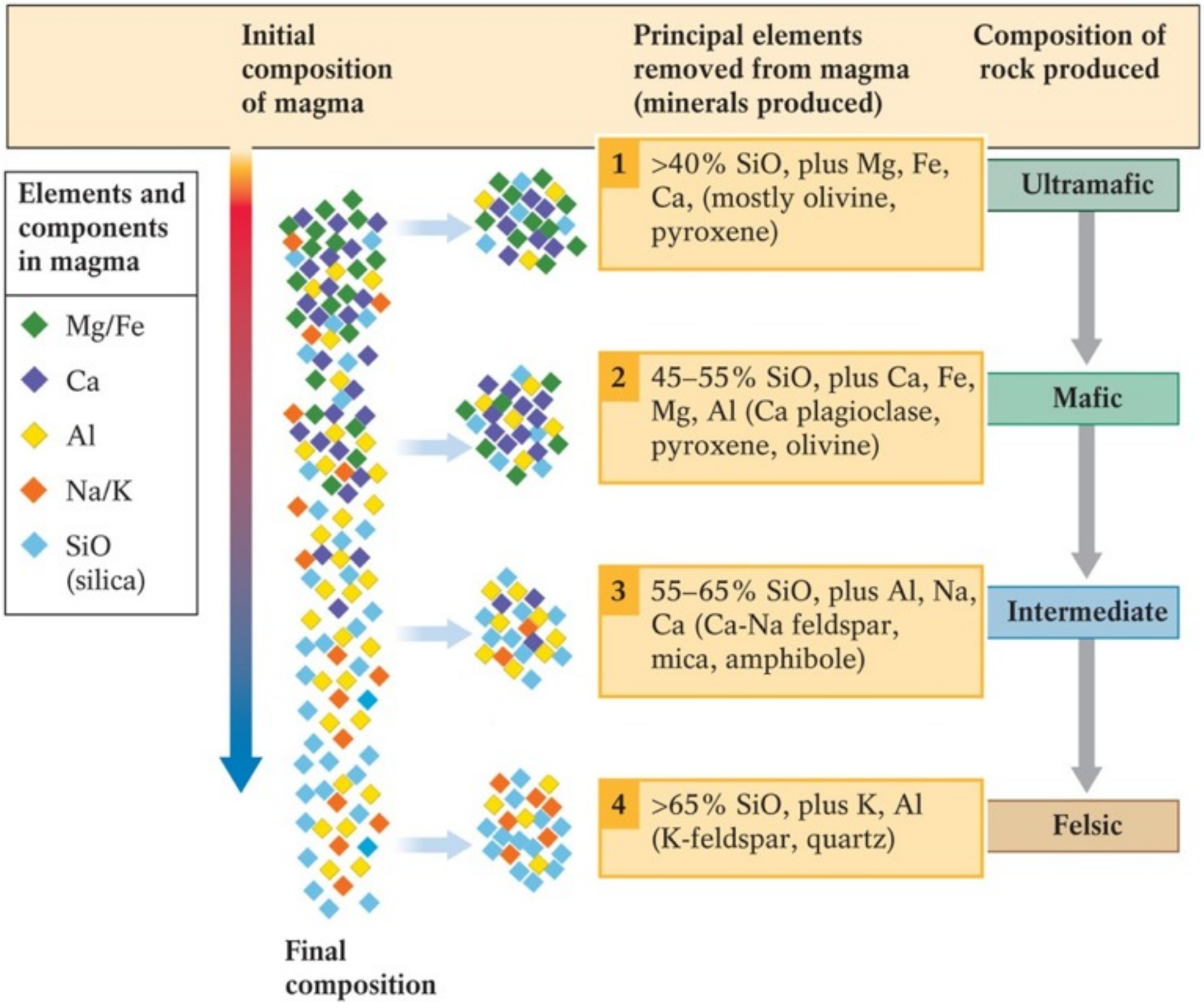


(b)

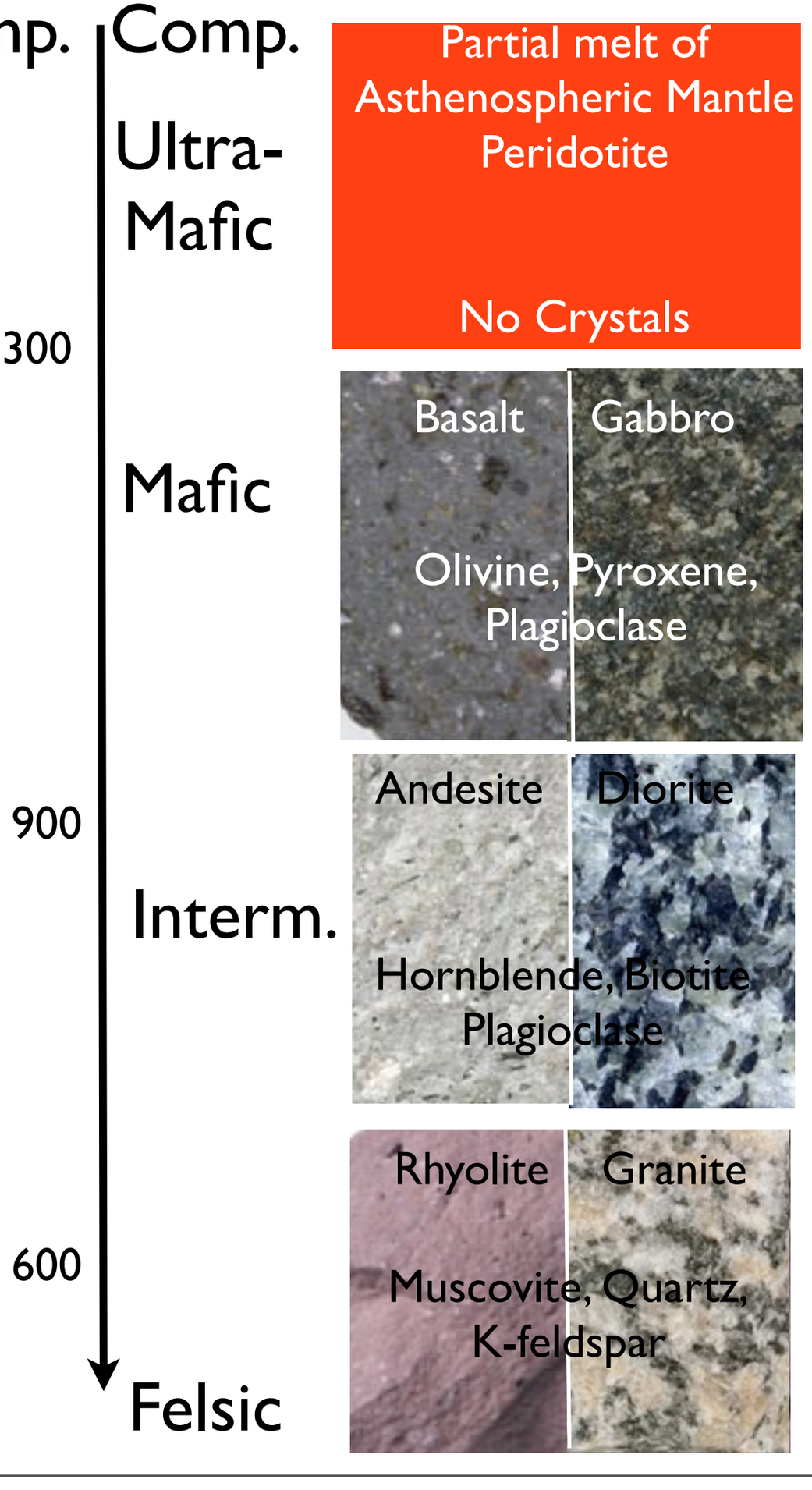
Temp.	Comp.	
	Ultra-Mafic	Partial melt of Asthenospheric Mantle Peridotite No Crystals
1300		
	Mafic	Basalt / Gabbro Olivine, Pyroxene, Plagioclase
900	Interm.	Andesite / Diorite Hornblende, Biotite Plagioclase
600	Felsic	Rhyolite / Granite Muscovite, Quartz, K-feldspar

Fractional Crystallization



Viscosity

is the resistance of a fluid to flow (the opposite of *fluidity)*



Viscosity

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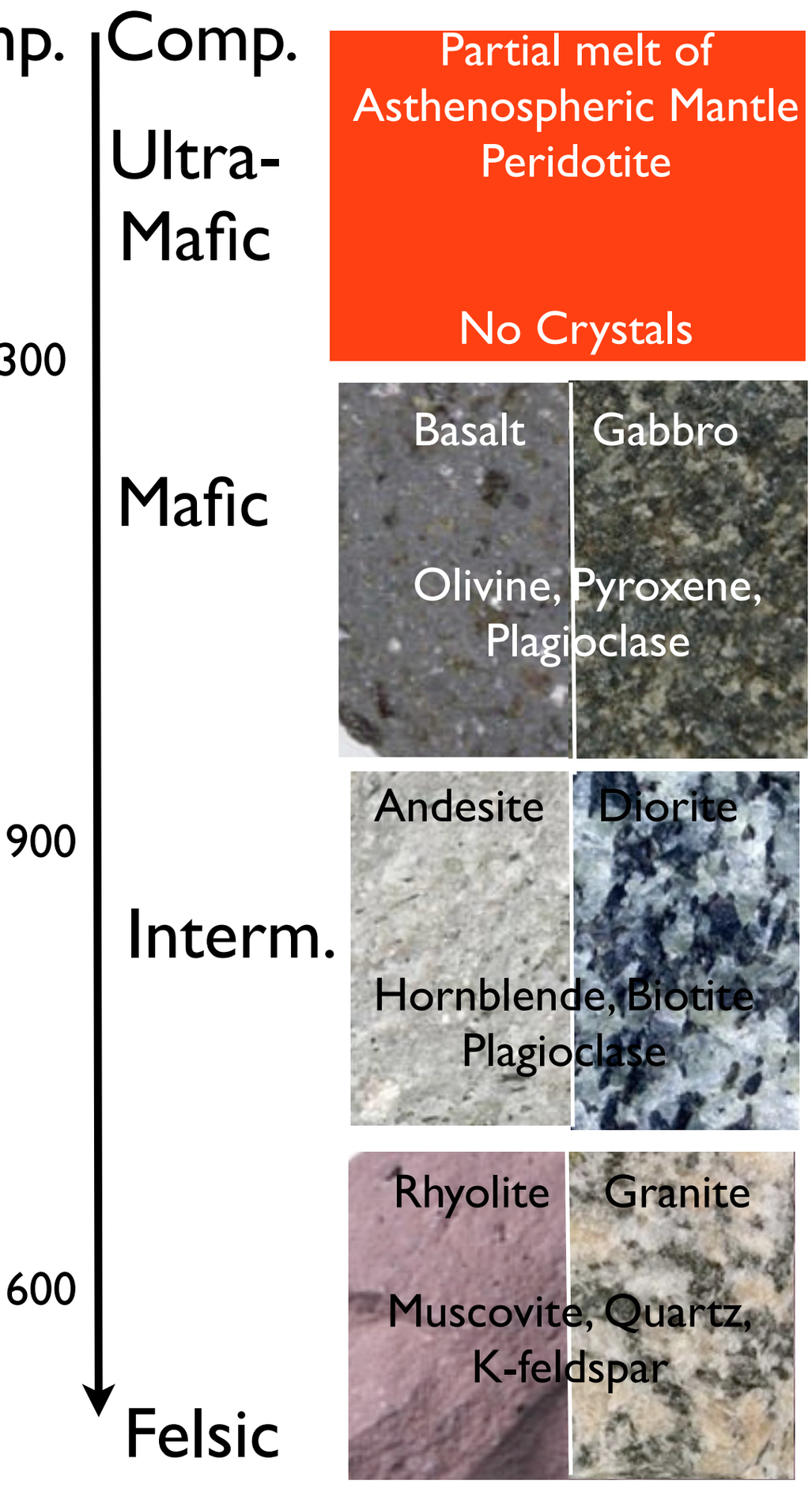
Viscosity <u>Increases</u> with decreasing temperature

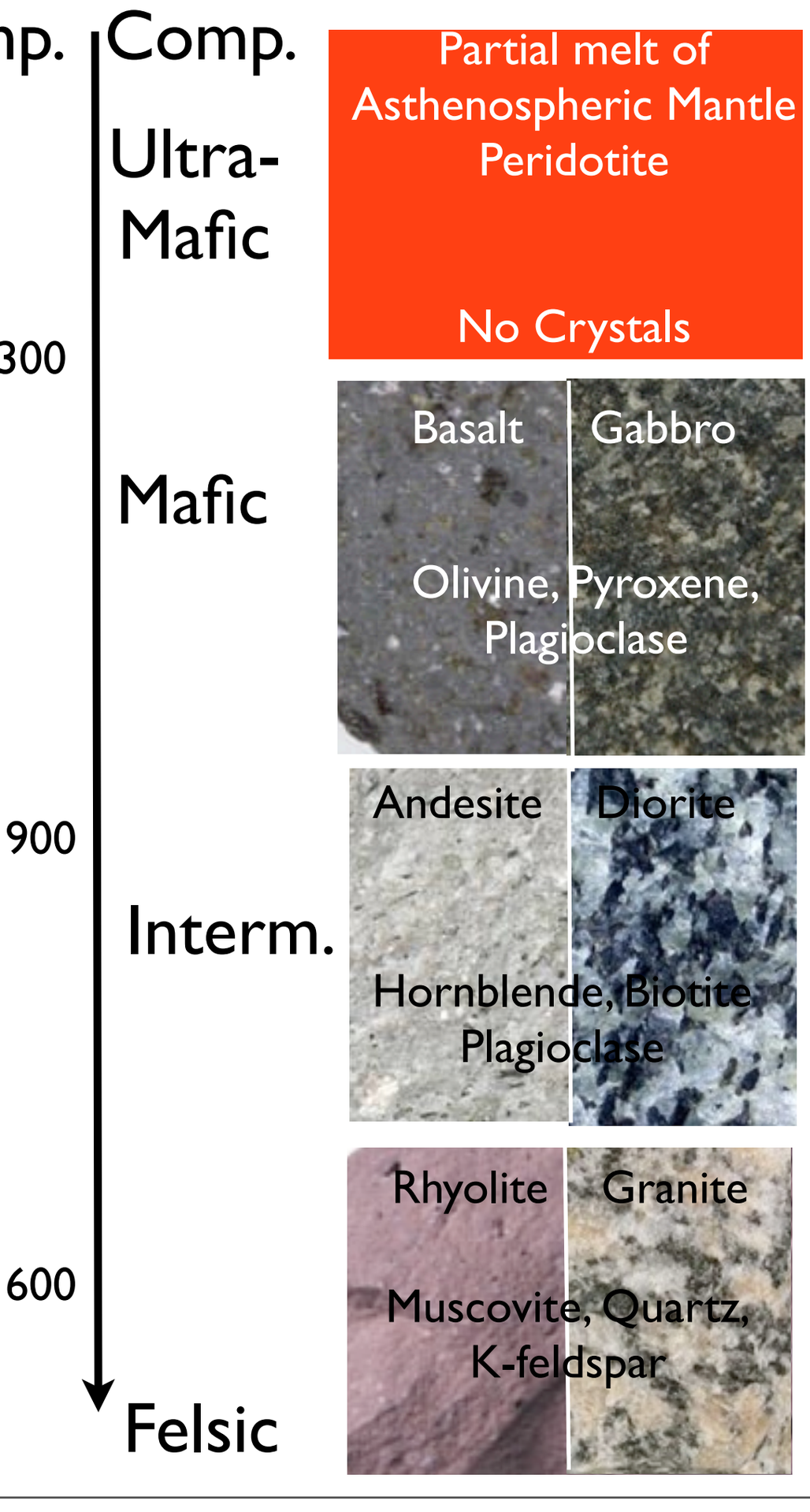


Viscosity

is the resistance of a fluid to flow (the opposite of *fluidity)*

Viscosity <u>Increases</u> with decreasing temperature

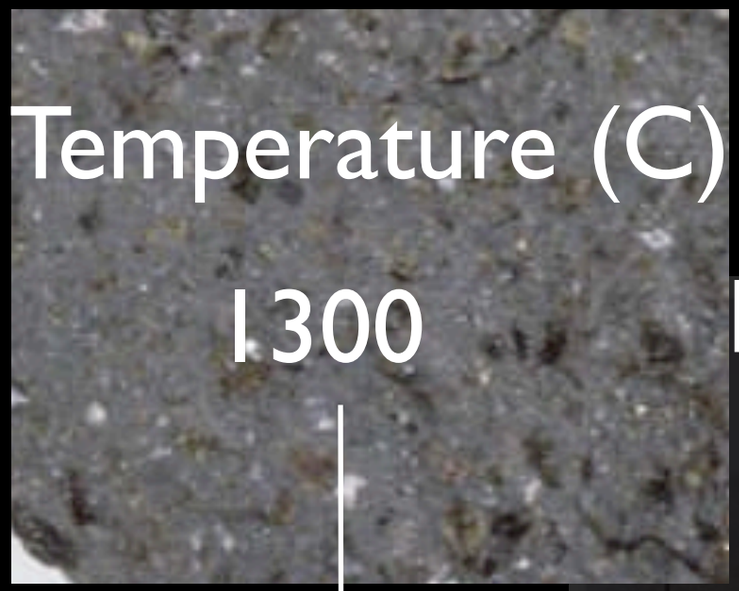
Viscosity <u>Increases</u> with increasing Silica Content



Tetrahedral Structure

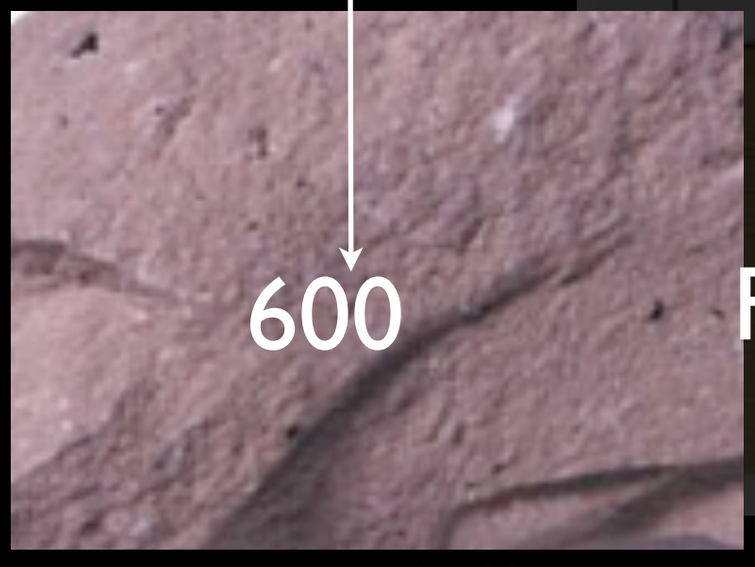
Composition

Temperature (C)



1300

600



Extrusive (effusive)

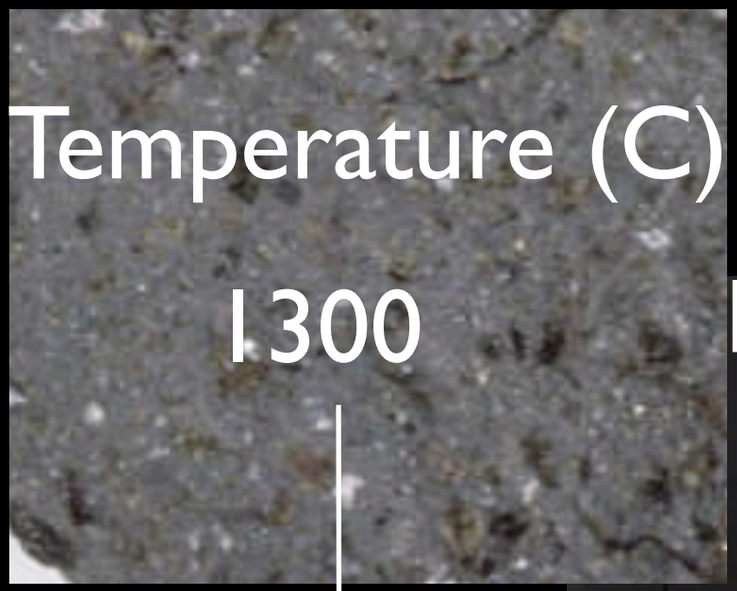
Mafic

Felsic

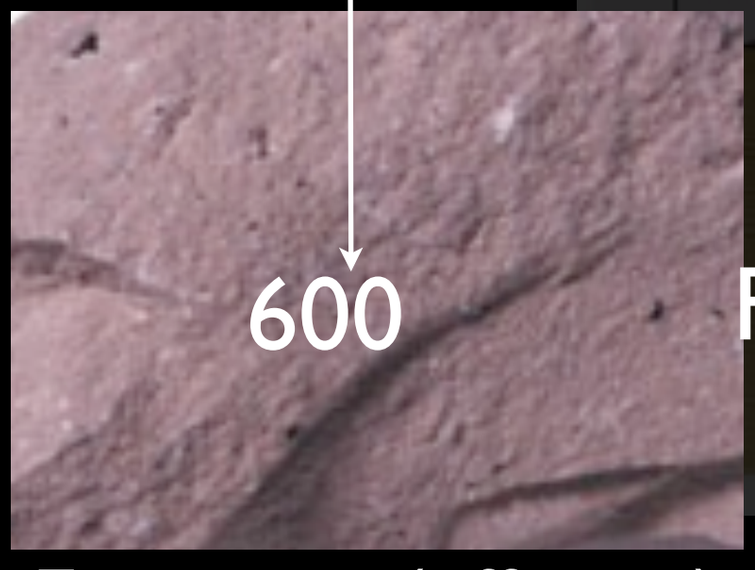
Composition

Temperature (C)

1300



600



Extrusive (effusive)

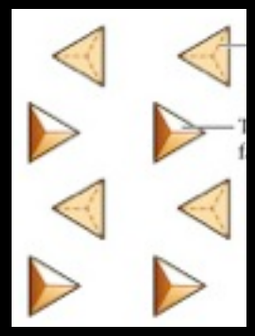
Mafic

Olivine

Pyroxene

Felsic

Tetrahedral Structure



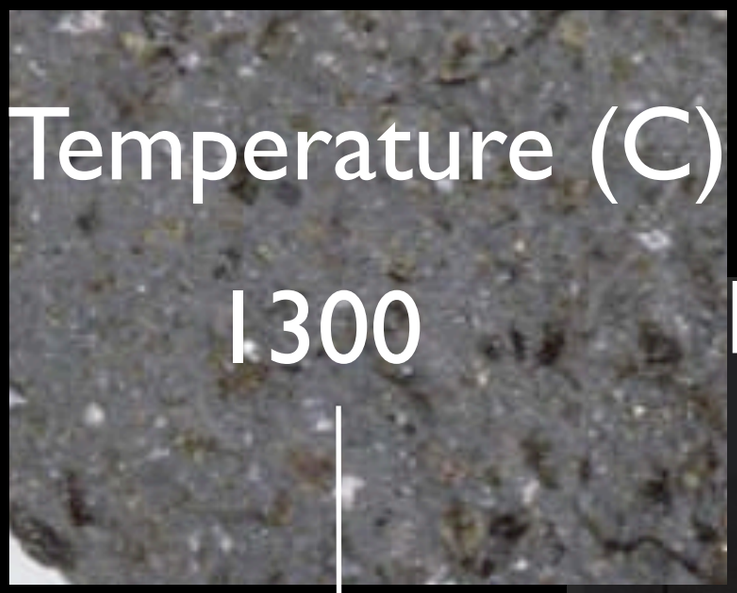
isolated

Single chain

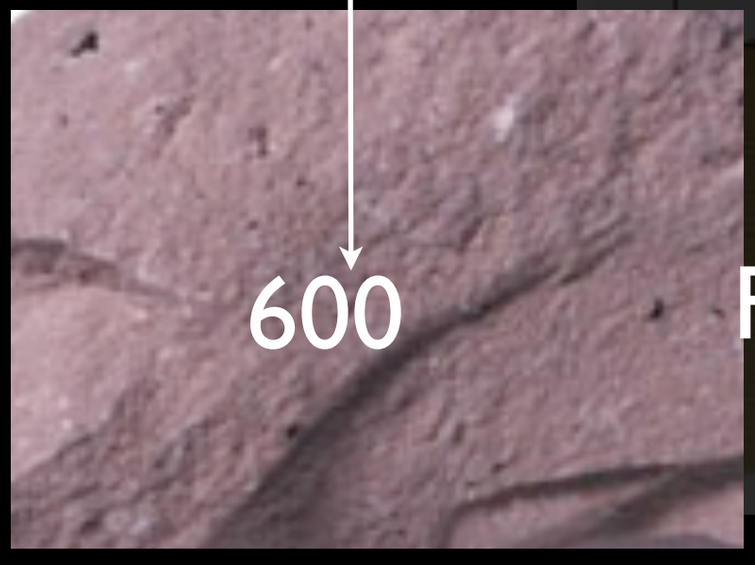
Composition

Temperature (C)

1300



600



Extrusive (effusive)

Mafic

Felsic

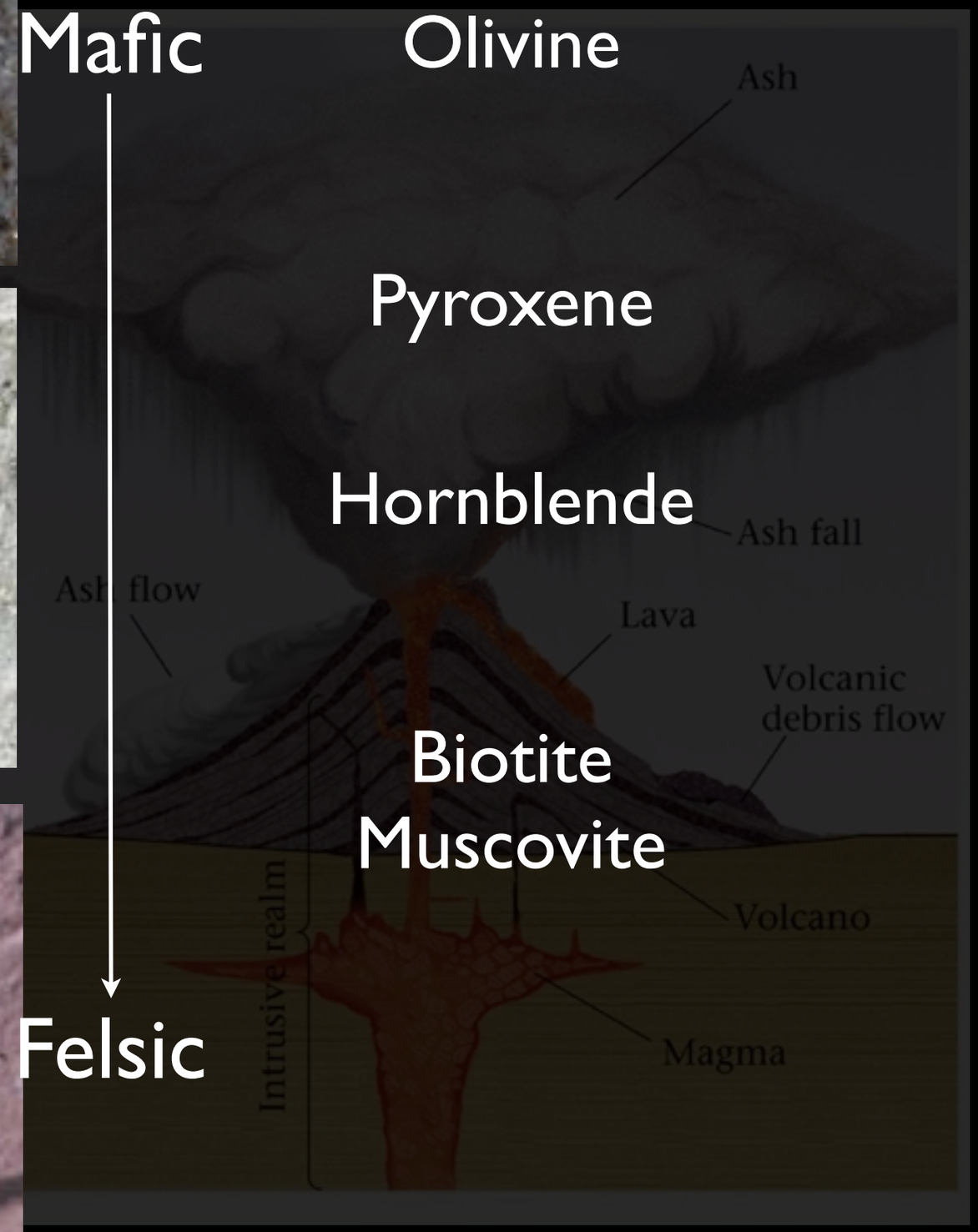
Olivine

Pyroxene

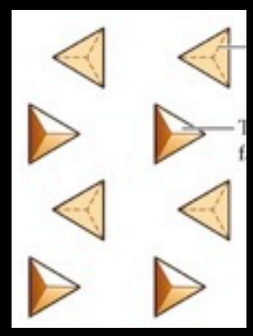
Hornblende

Biotite

Muscovite

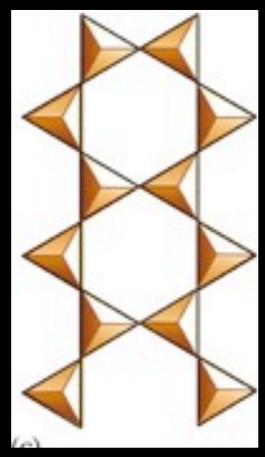


Tetrahedral Structure



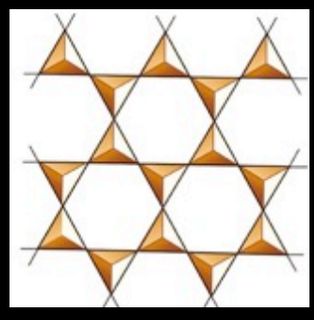
isolated

Single chain



Double chain

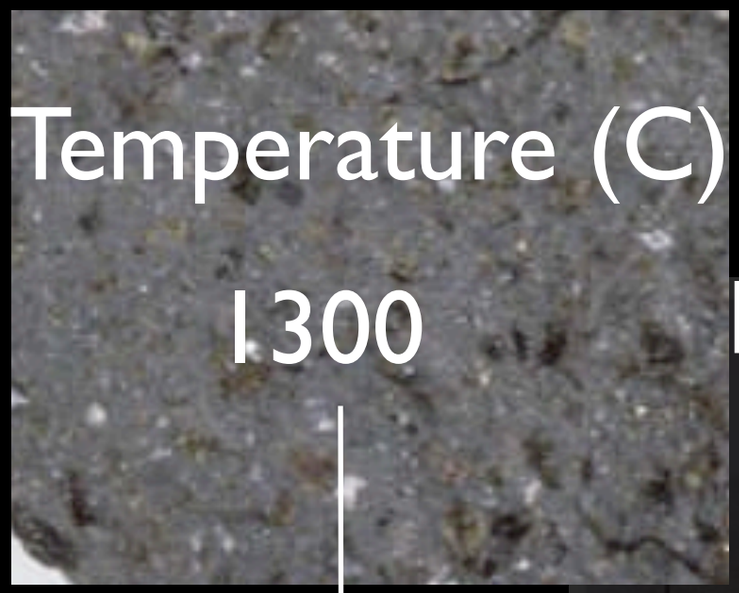
2D Sheet



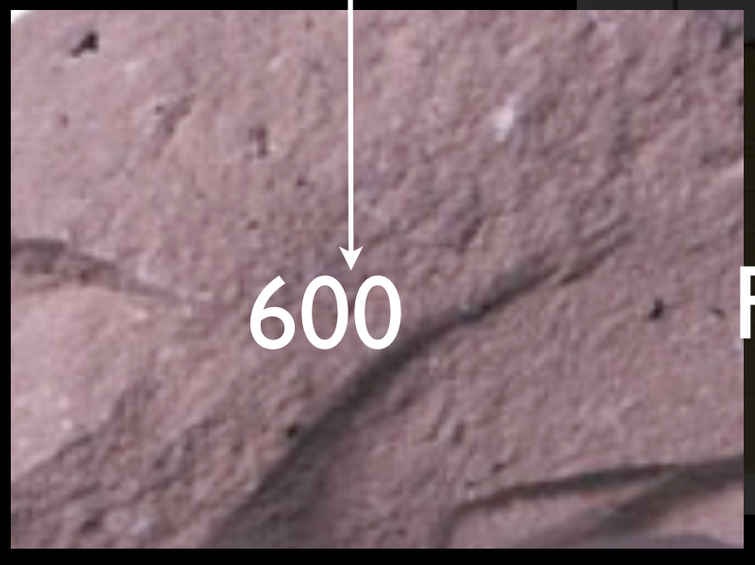
Composition

Temperature (C)

1300



600



Extrusive (effusive)

Mafic

Felsic

Olivine

Pyroxene

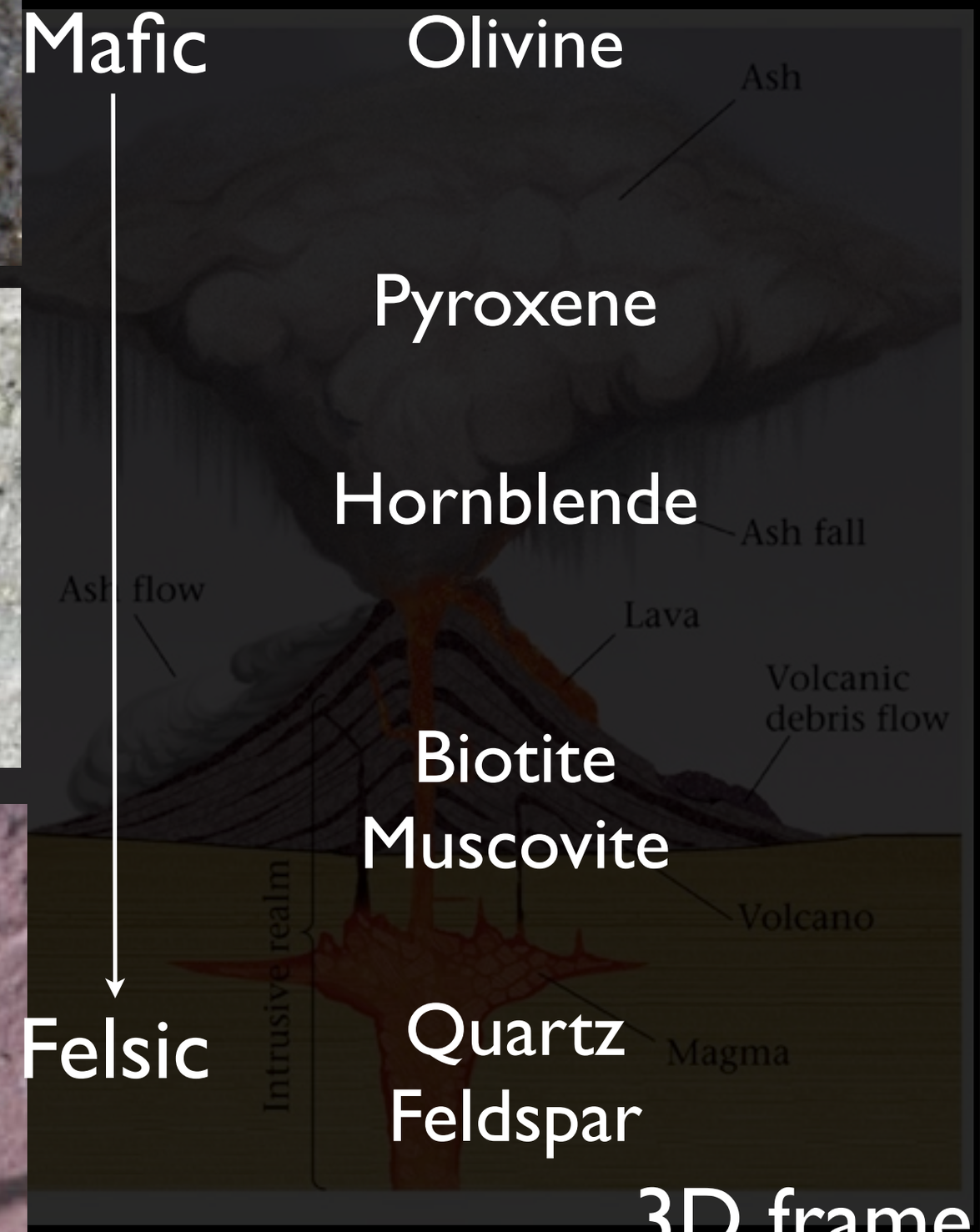
Hornblende

Biotite

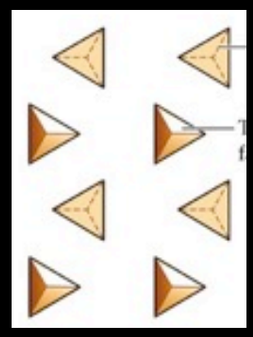
Muscovite

Quartz

Feldspar

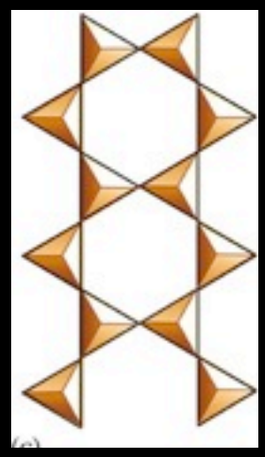


Tetrahedral Structure



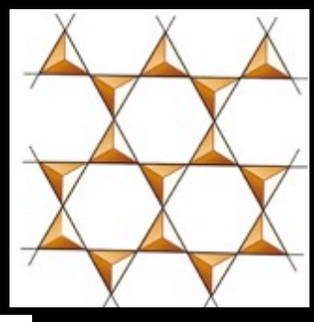
isolated

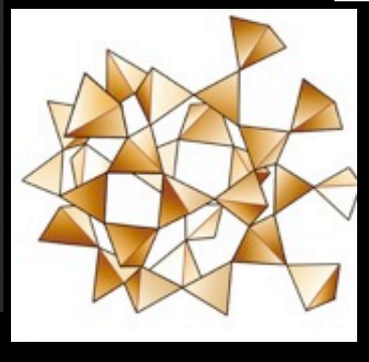
Single chain



Double chain

2D Sheet



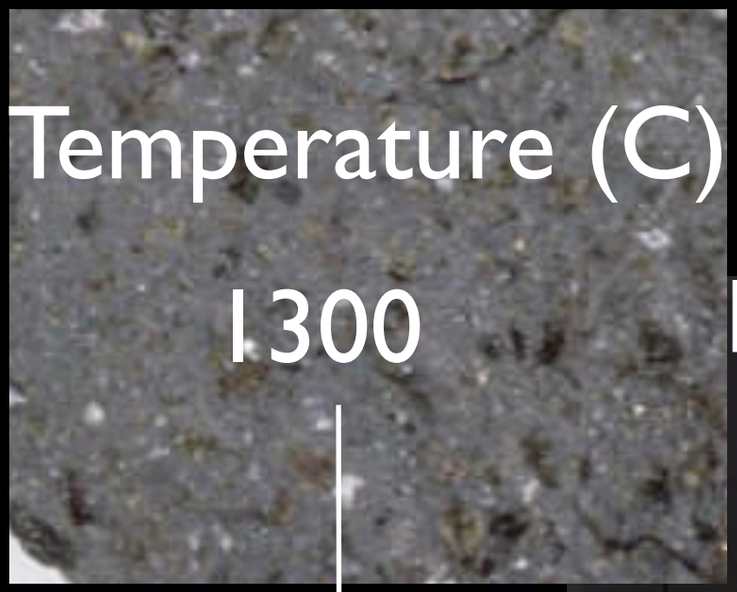


3D frame

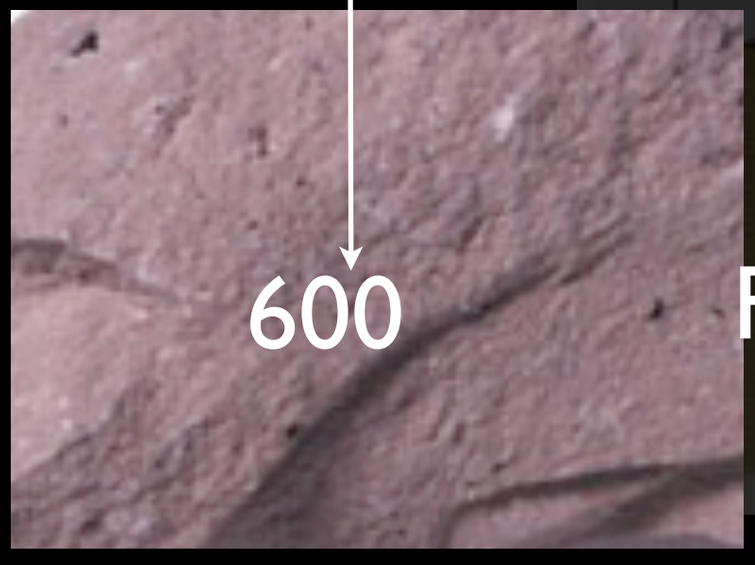
Composition

Temperature (C)

1300



600



Extrusive (effusive)

Mafic

Felsic

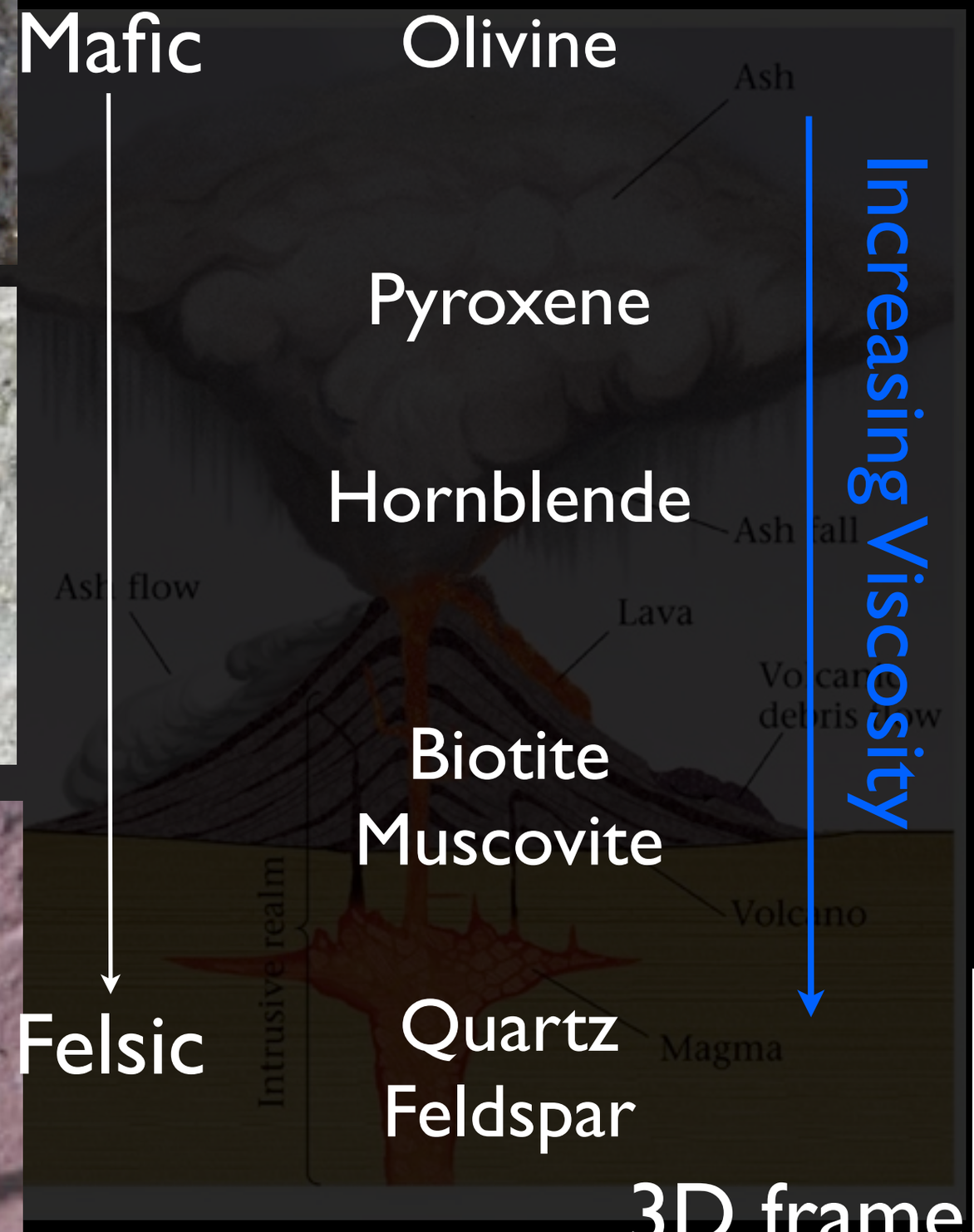
Olivine

Pyroxene

Hornblende

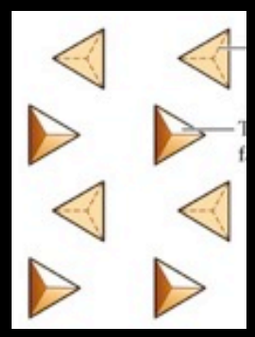
Biotite
Muscovite

Quartz
Feldspar



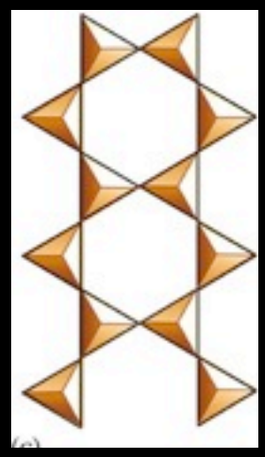
Increasing Viscosity

Tetrahedral Structure

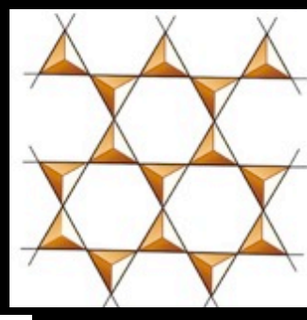


isolated

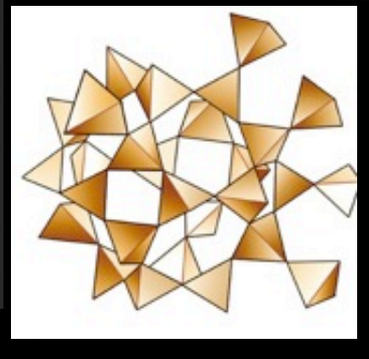
Single chain



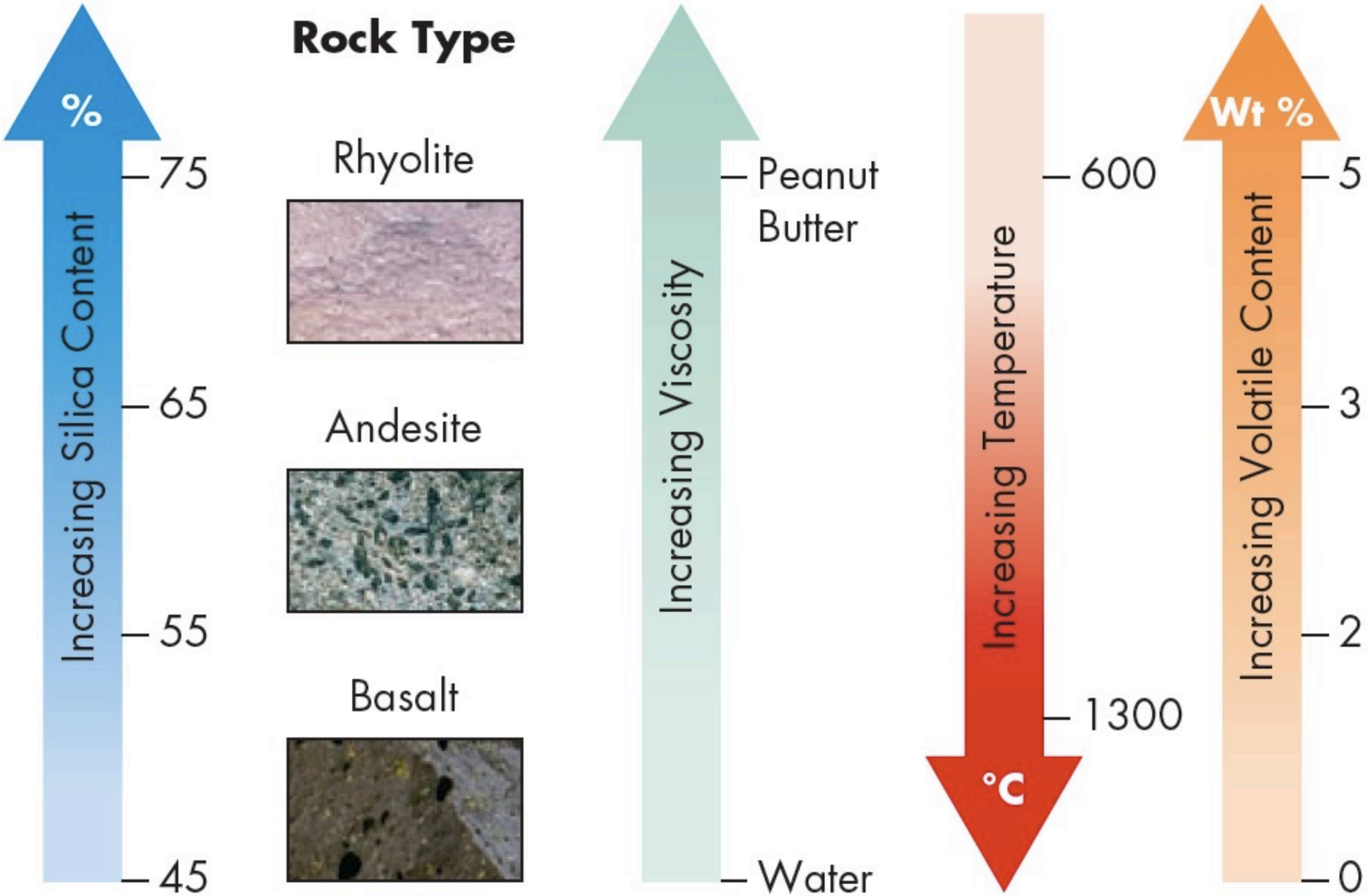
Double chain



2D Sheet



3D frame


Rock Type
%
Silica Content
75
65
55
45
Increasing
Rhyolite
Andesite
Basalt
Peanut
Butter
Water
Increasing Viscosity
600
1300
°C
Increasing Temperature
Wt %
Volatile Content
5
3
2
0.1
Increasing

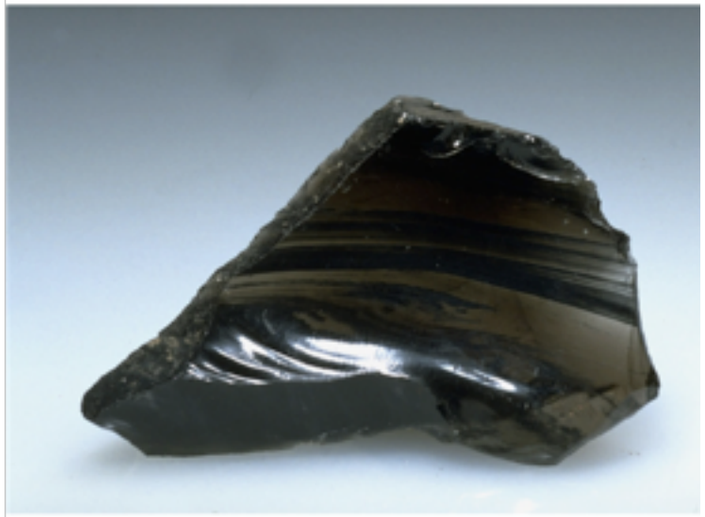
Pahoehoe Lava

Viscosity of Basaltic Lava

A’ a Lava

Viscosity of Andesite Lava

Medicine Lake Volcano, CA



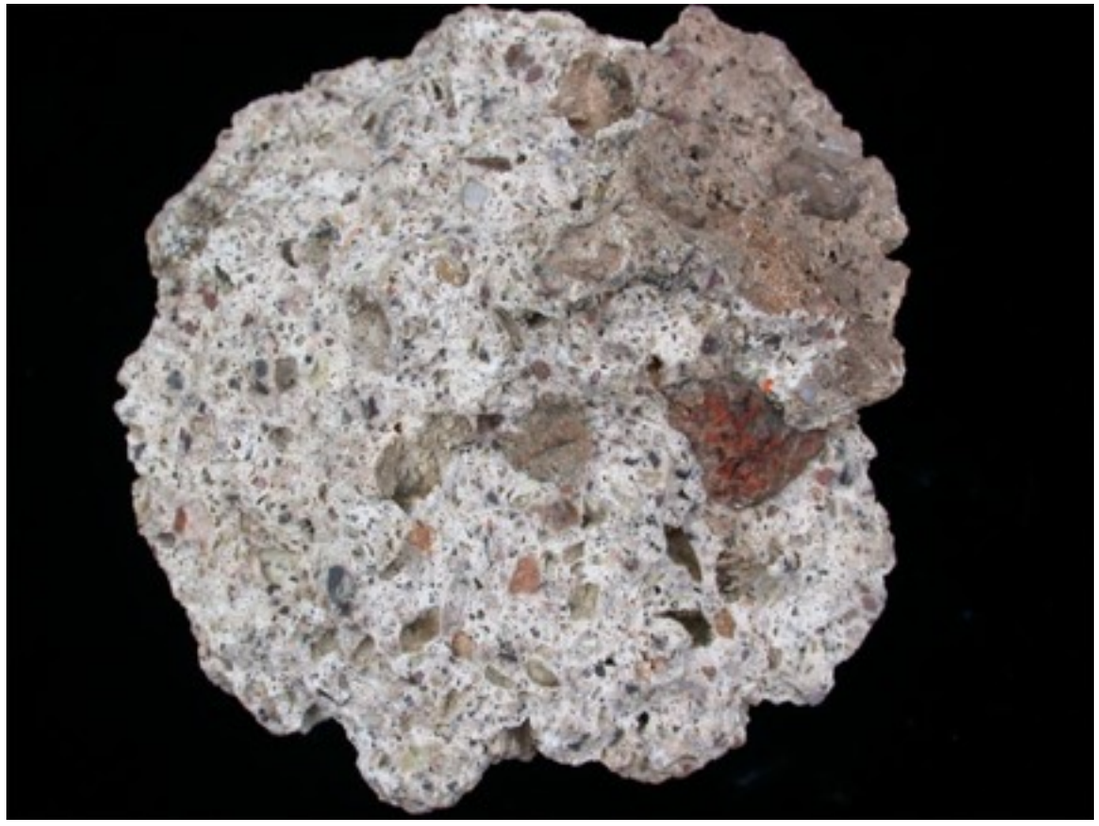
Viscosity of Rhyolite Lava (Obsidian flow)

Medicine Lake Volcano, CA

Other Extrusive Igneous Rocks Textures

Aphanitic (no visible crystals)

Vesicular or Frothy



Pyroclastic (fragments of rock and ash)

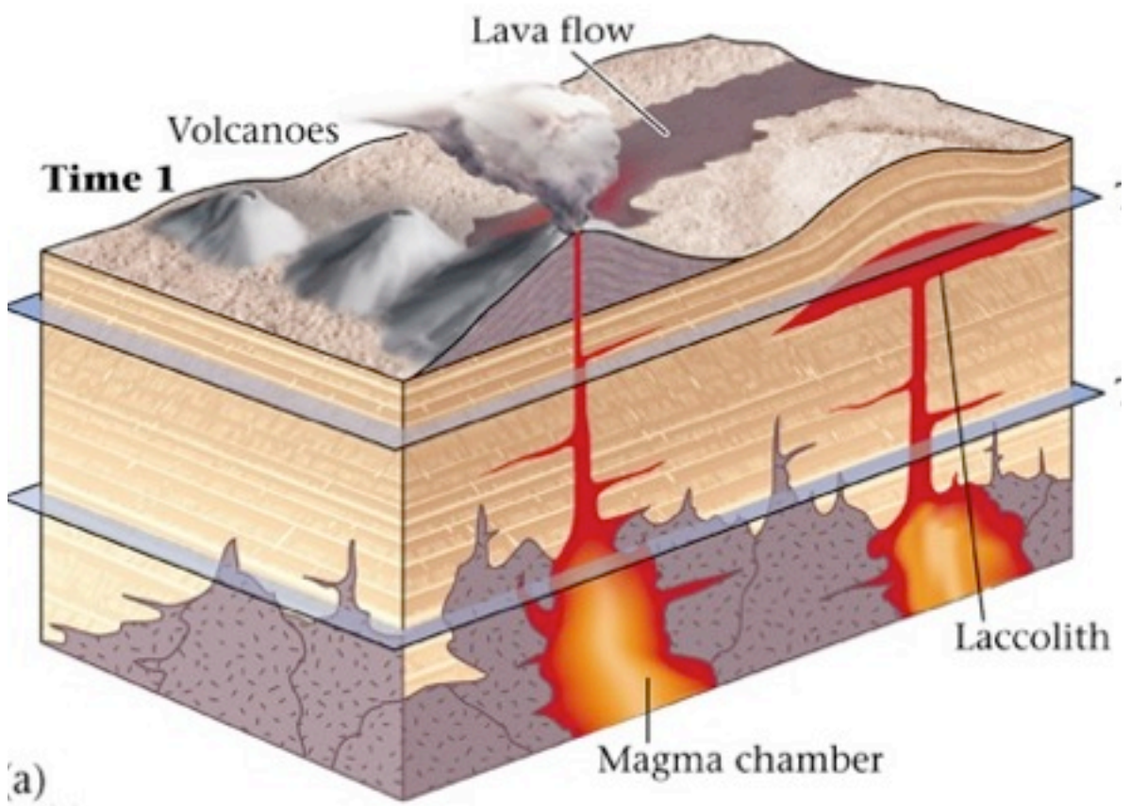
Other Intrusive Igneous Rocks Texture

Pegmatite (crystals > 1cm)

Cathedral Peak Granite
Tuolumne Meadows, Yosemite NP

Evidence of Magma flow

Cathedral Peak Granite Lee Vining Canyon



Evidence of Magma flow

Cathedral Peak Granite Lee Vining Canyon

Evidence of Magma flow

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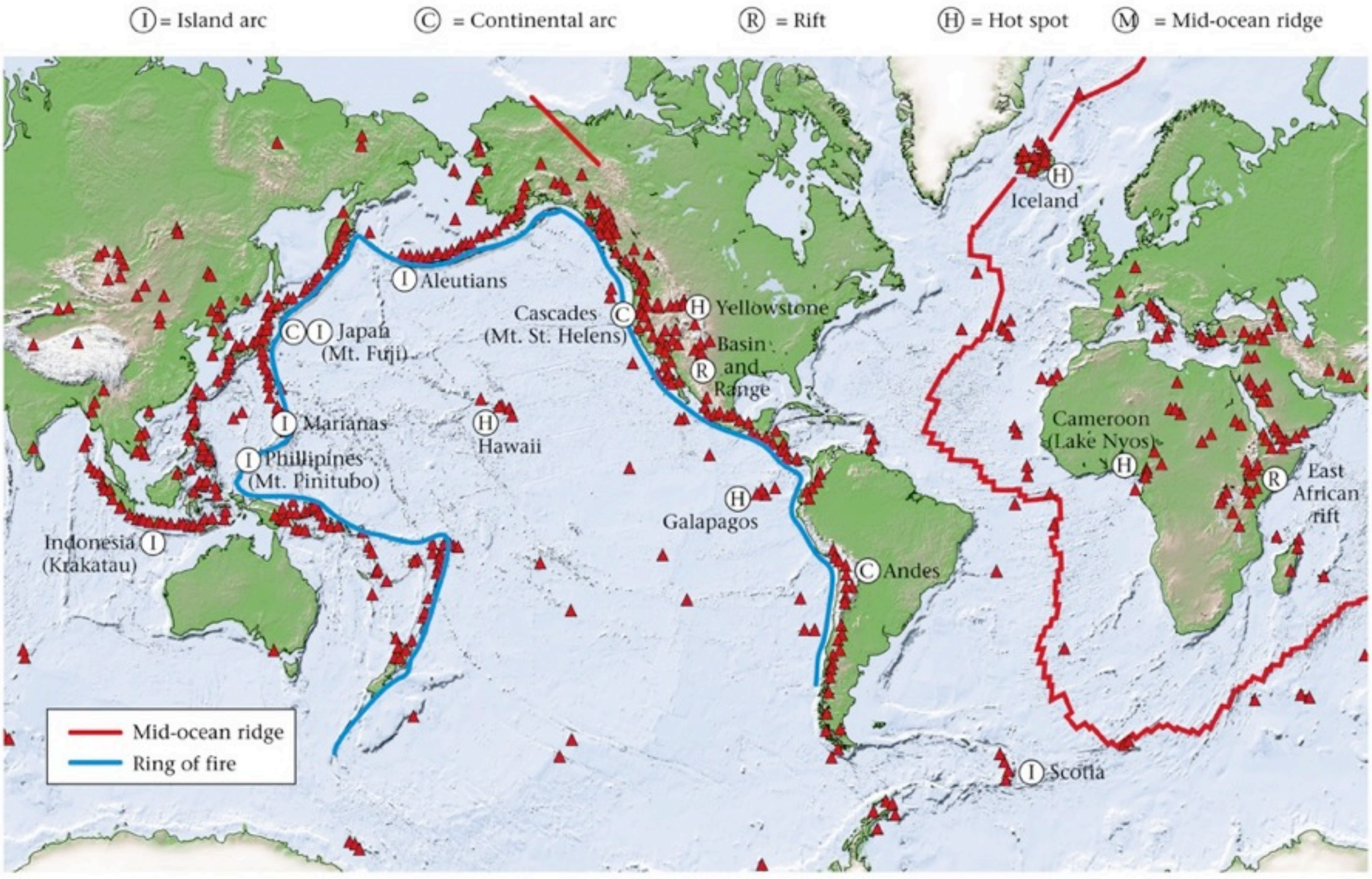
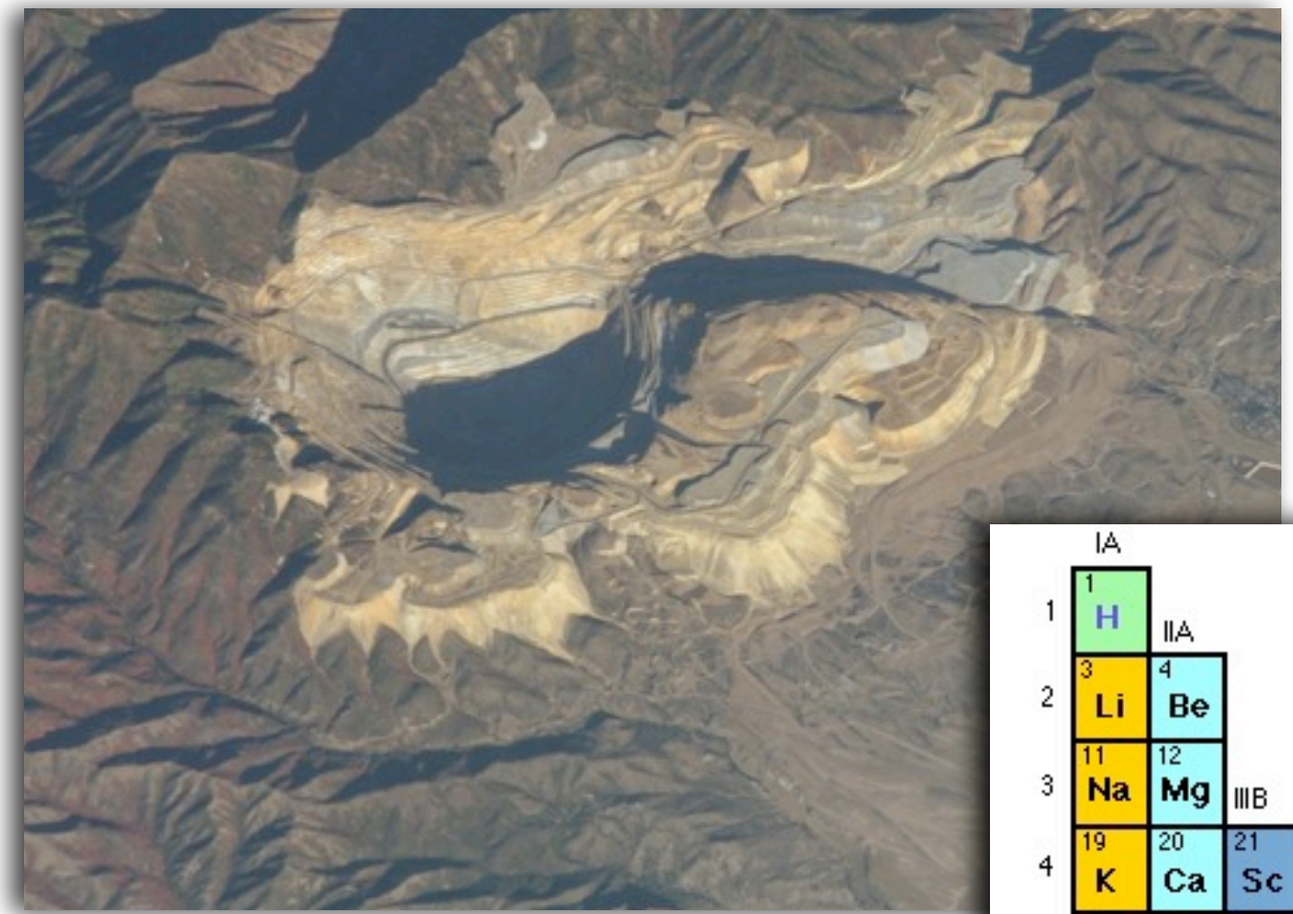
Evidence of Magma flow

Cathedral Peak Granite Lee Vining Canyon

The Real Igneous Rock Factory



Brigham Mine



Periodic Table of Elements

	IA	IIA	IIIB	IVB	VB	VIB	VIIB	—— VII ——	IB	IB	IIIA	IVA	VA	VIA	VIIA	0
1	1 H															2 He
2	3 Li	4 Be									5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg									13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 *La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 +Ac	104 Rf	105 Ha	106 106	107 107	108 108	109 109	110 110								

* Lanthanide Series	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
+ Actinide Series	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Legend - click to find out more...

H - gas	Li - solid	Br - liquid	Tc - synthetic
Non-Metals	Transition Metals	Rare Earth Metals	Halogens
Alkali Metals	Alkali Earth Metals	Other Metals	Inert Elements

How is it that the Composition of Igneous rocks can be variable from felsic to mafic?

A) Because felsic rocks come from melting of other felsic rocks, whereas mafic rocks from melting of other mafic rocks.

B) Because fractional crystallization causes the melt to become more mafic by crystallizing mafic minerals first.

C) Because fractional crystallization causes the melt to become more felsic by crystallizing felsic minerals first.

D) Because fractional crystallization causes the melt to become more felsic by crystallization of mafic minerals first.

E) Because Partial melting of the asthenosphere yields rocks that are variable in composition.

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A lava flow with low viscosity has a high resistance to flow and therefore tends to be thicker.

A) True

B) False

A lava flow with low viscosity has a high resistance to flow and therefore tends to be thicker.

A) True

B) False

The viscosity of lava and magma can be increased by

A) Increasing the temperature and by increasing the felsic content.

B) Decreasing the temperature and by increasing the felsic content.

C) Decreasing the temperature and by increasing the mafic content.

D) Temperature is not important only the composition of the melt.

E) Only by decreasing the Temperature, composition is not important.

The viscosity of lava and magma can be increased by

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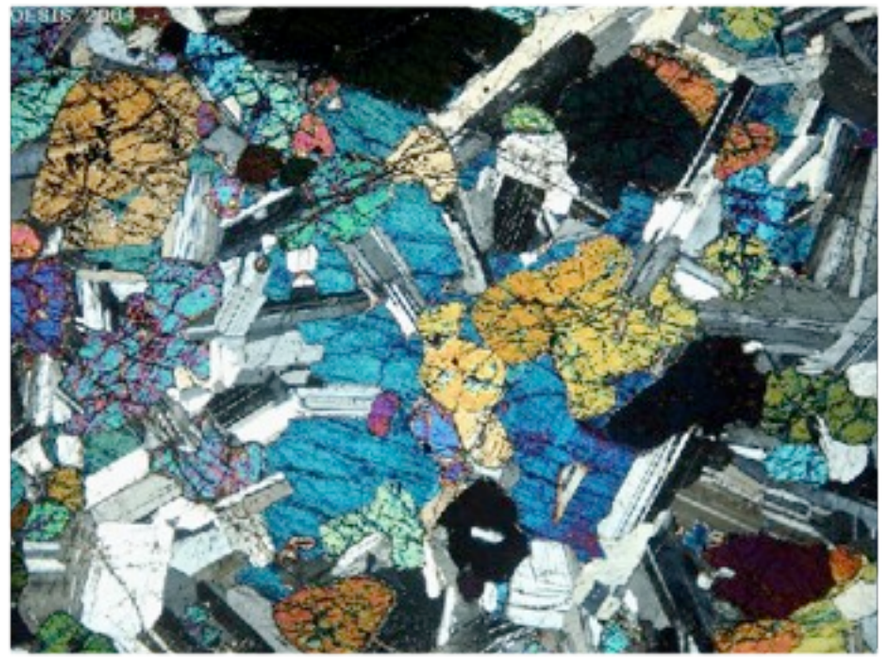
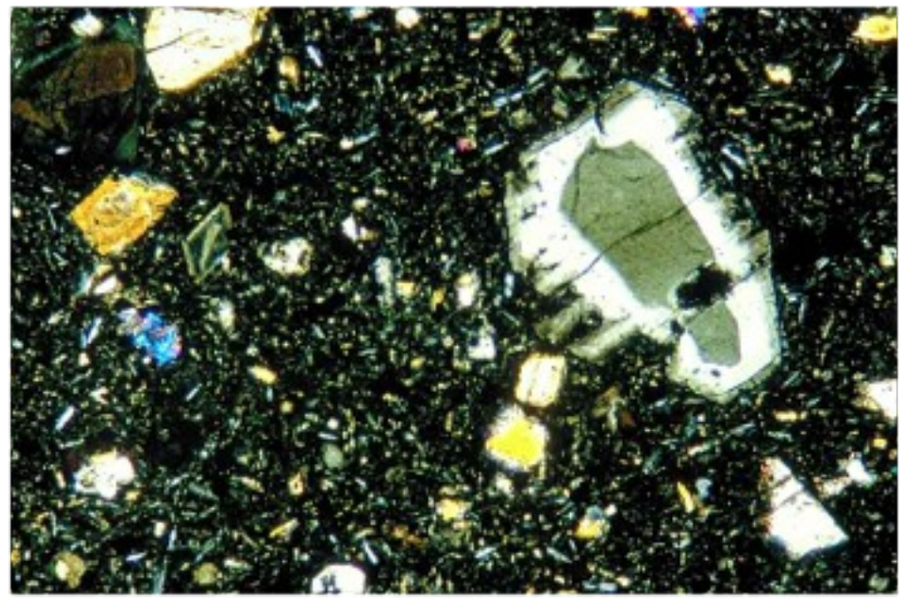
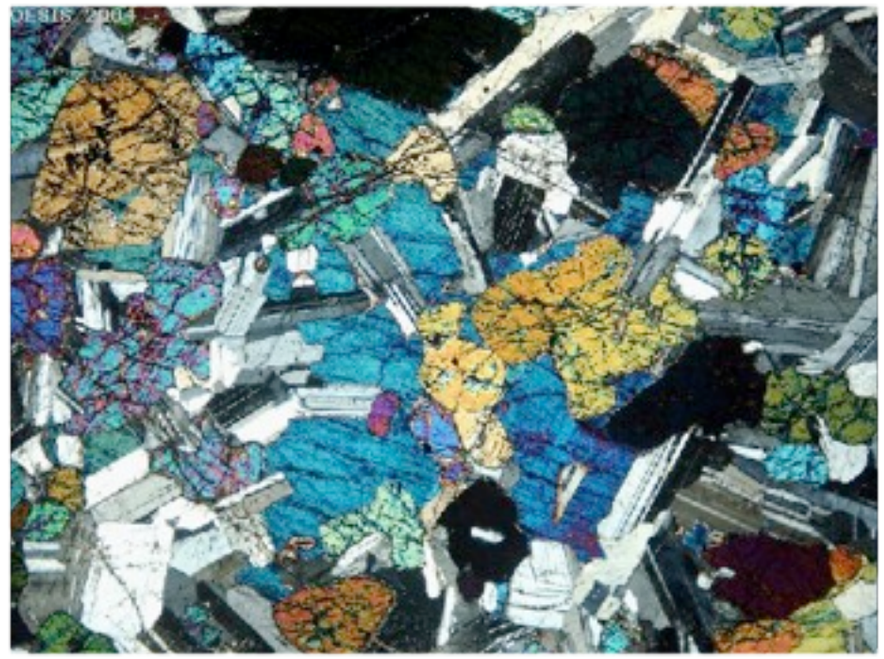
The upper image shows an intrusive igneous Rock (plutonic), while the lower image shows and extrusive volcanic rock.

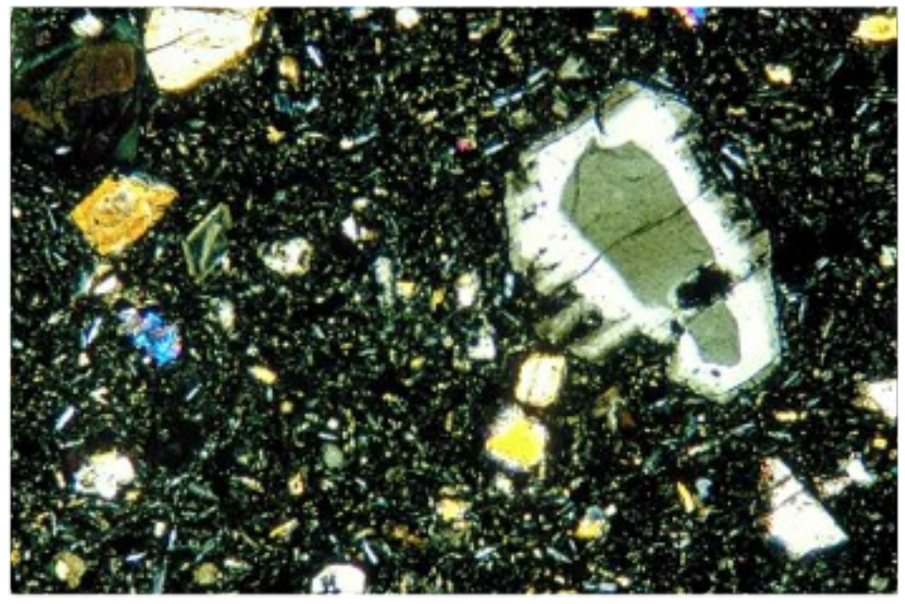




A) True
B) False
C) Don't know

The upper image shows an intrusive igneous Rock (plutonic), while the lower image shows and extrusive volcanic rock.





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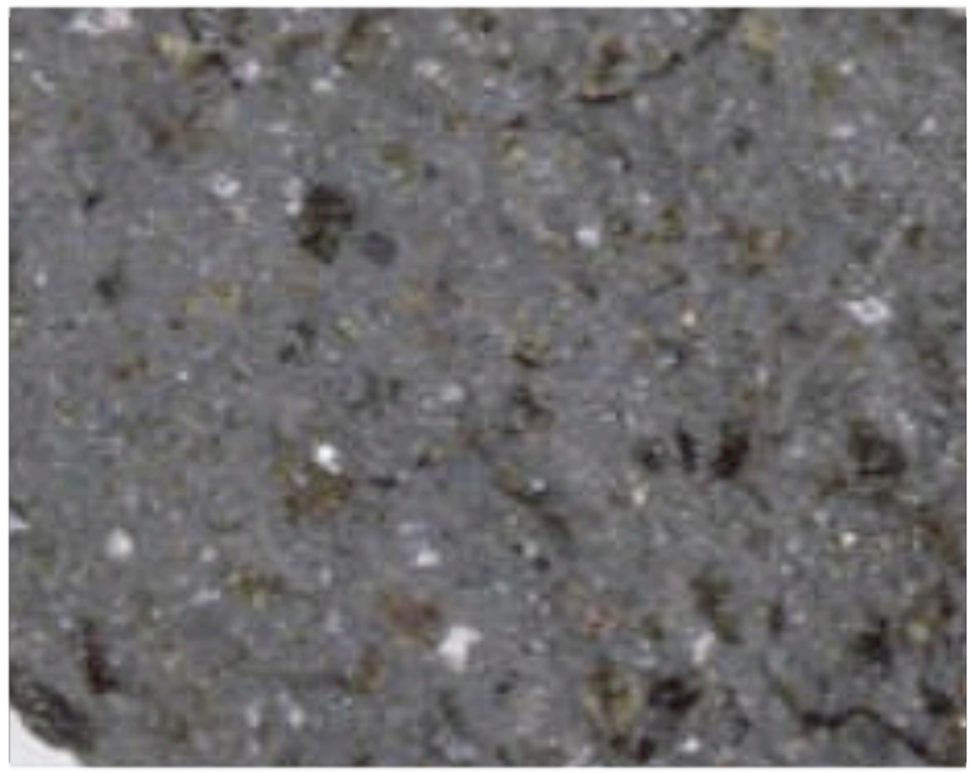

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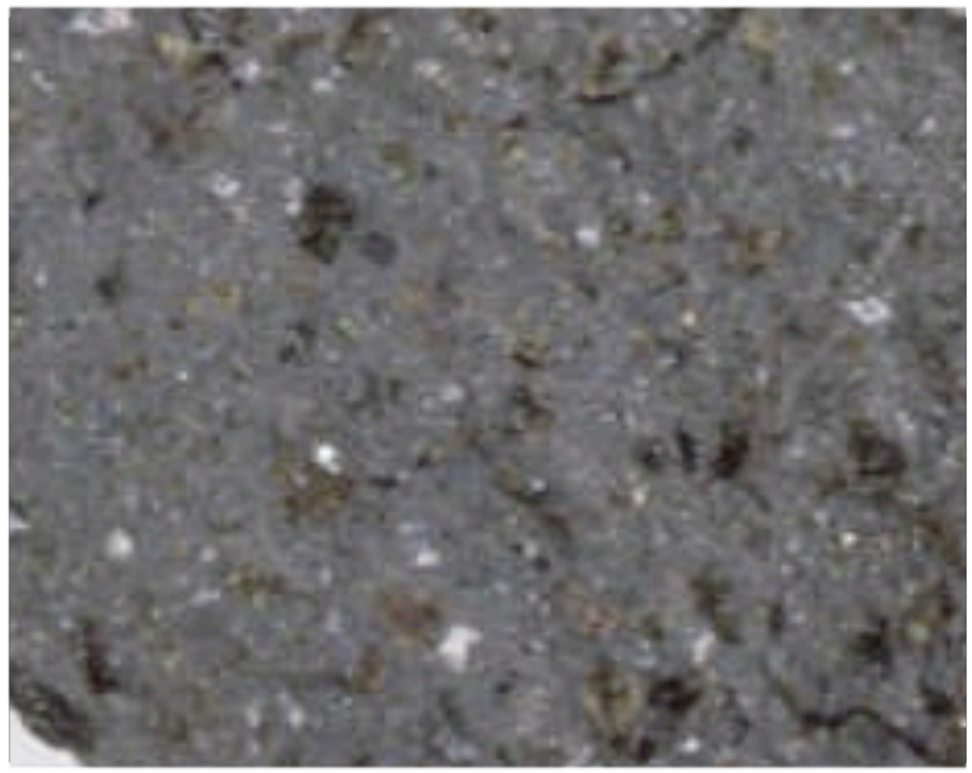
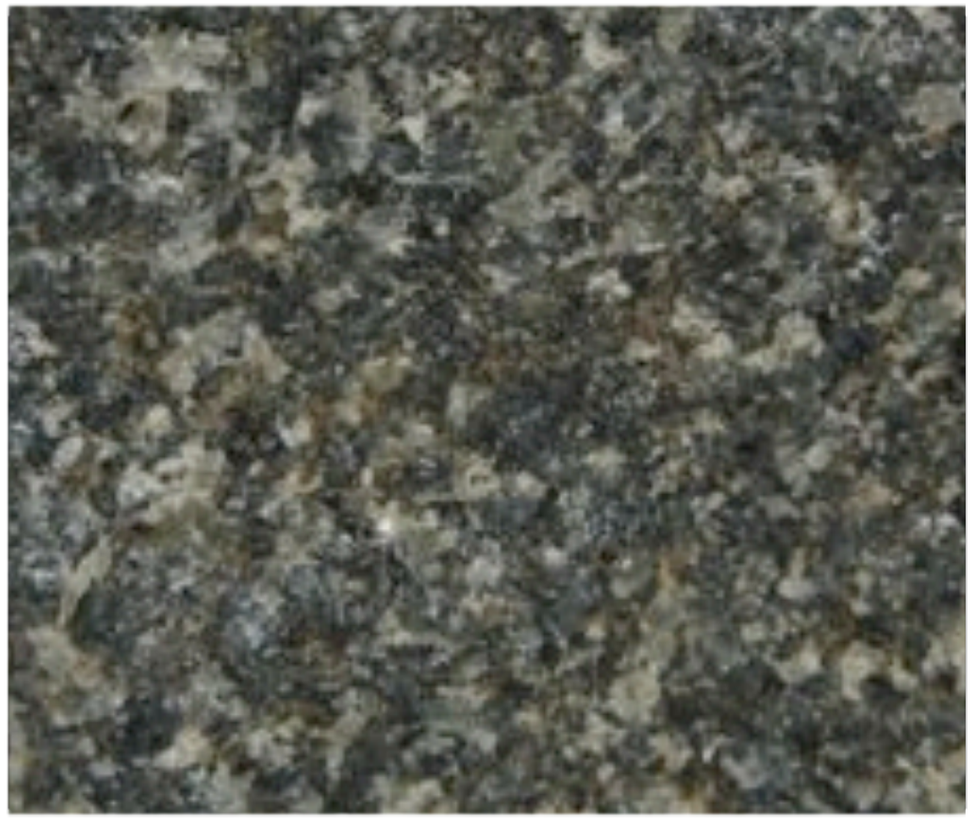
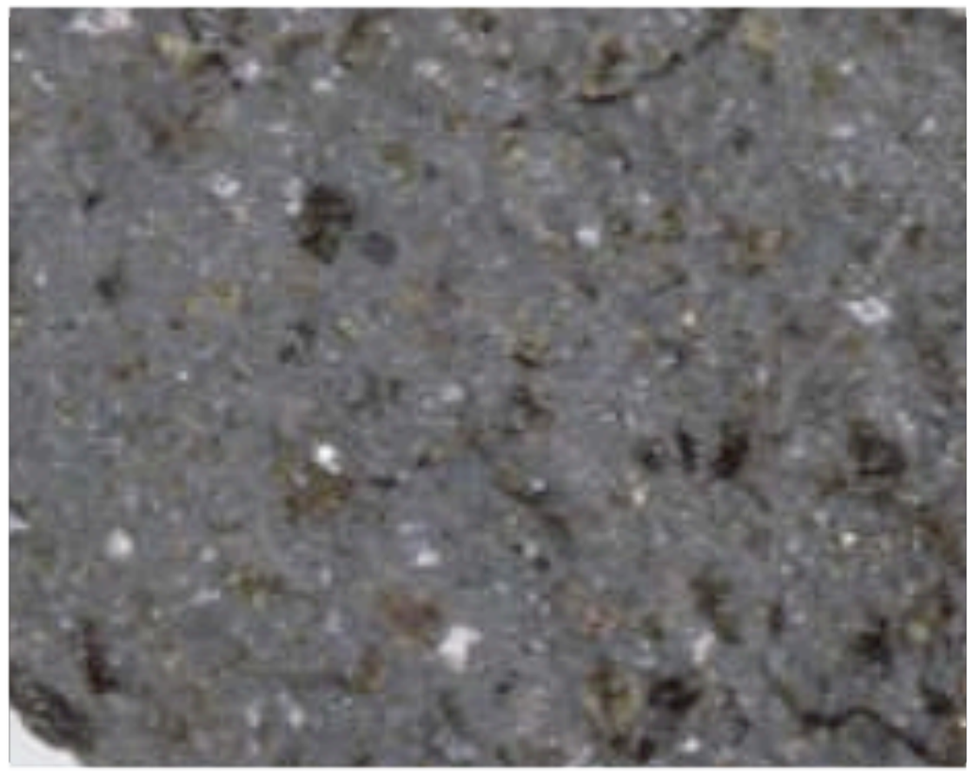


The upper image is an example of a phaneritic rock, while the lower image is an example of a porphiritic rock.





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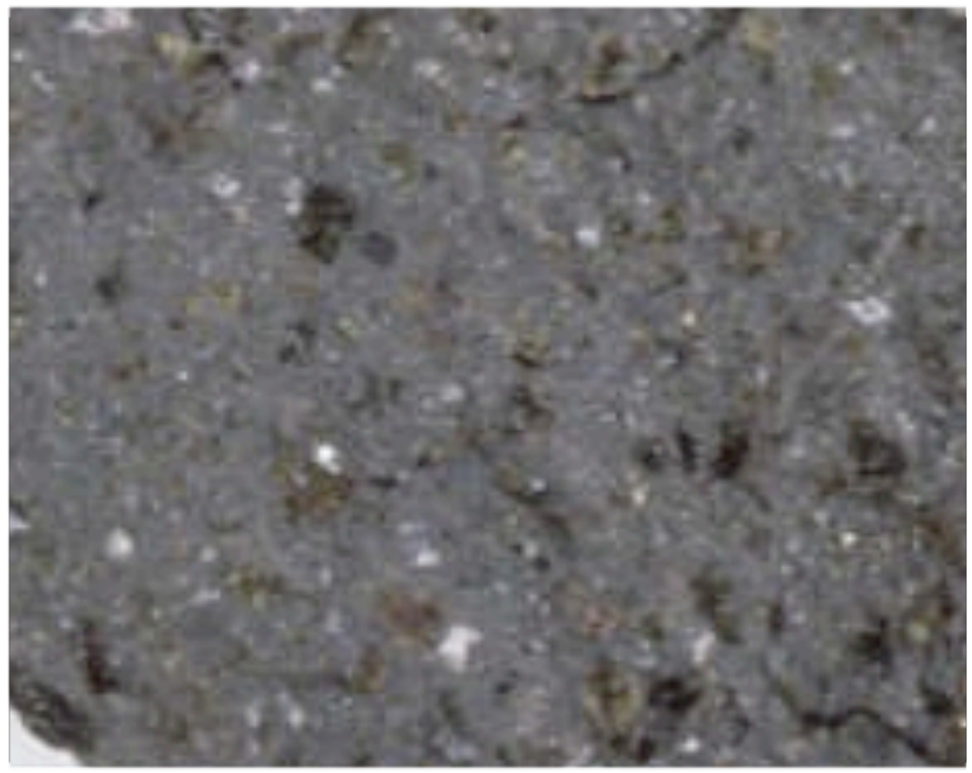

Next Class

1) Quiz: Chapter 4 Vocabulary/ REview Chapter 3