Magma Evolution Activity

You have 400 grams of magma atoms
(*oxygen, the most abundant, is not included*)
Each poker chip is
1 gram of a specific atom.
Separate chips into colored stacks.

What is the highest percentage atom?
Next most abundant?

Magma Evolution Activity

Si (silicon) = white
Al (aluminum) = green
K (potassium) = yellow
Ca (calcium) = lilac
Fe (iron) = red
Mg (magnesium) = orange
OH (hydroxide – water) = light blue
Na (sodium) = blue
P, Mn, Ti, Au, Ag (rare elements) = black

Magma Evolution Activity

What percentage of the magma is Silicon right now?
(# ÷ 400) x 100 = *percentage* =

What should happen to that percentage as we evolve the magma chamber?

	Primitive Magma	%
Si	200	50
Al	61	15
K	8	2
Ca	26	6
Fe	42	10
Mg	35	9
OH	17	4
Na	12	3
P, Mn, Ti, Au..	1	0
TOTAL	402	100

Magma Evolution Activity

What percentage of the magma is Water right now?
(# ÷ 400) x 100 = *percentage* =

What should happen to that percentage as we evolve the magma chamber?

	Primitive Magma	%
Si	200	50
Al	61	15
K	8	2
Ca	26	6
Fe	42	10
Mg	35	9
OH	17	4
Na	12	3
P, Mn, Ti, Au..	1	0
TOTAL	402	100

Magma Evolution Activity

What percentage of the magma is Fe & Mg right now?
(# ÷ 400) x 100 = *percentage* =

What should happen to that percentage as we evolve the magma chamber?

	Primitive Magma	%
Si	200	50
Al	61	15
K	8	2
Ca	26	6
Fe	42	10
Mg	35	9
OH	17	4
Na	12	3
P, Mn, Ti, Au..	1	0
TOTAL	402	100

Magma Evolution Activity

What percentage of the magma is Gold (Au) right now?
(# ÷ 400) x 100 = *percentage* =

What should happen to that percentage as we evolve the magma chamber?

	Primitive Magma	%
Si	200	50
Al	61	15
K	8	2
Ca	26	6
Fe	42	10
Mg	35	9
OH	17	4
Na	12	3
P, Mn, Ti, Au..	1	0
TOTAL	402	100

Magma Evolution Activity

Using the mineral handout (in bag), create a poker stack for olivine.
Review how to create a mineral stack, based on chemical formula.
You will do this same thing as minerals are removed from magma.
ALWAYS KEEP MINERALS IN THEIR OWN SEPARATE STACKS, to prevent mistakes.

		Olivine	Plagioclase (Ca)	Pyroxene	Magnetite
		$FeMgSiO_4$	$CaAl_2Si_2O_8$	$CaMgSi_2O_6$	Fe_3O_4
white	Si	1	2	2	
green	Al		2		
yellow	K				
lilac	Ca		1	1	
red	Fe	1			3
orange	Mg	1		1	
light blue	OH				
blue	Na				
black	P, Mn, Ti				

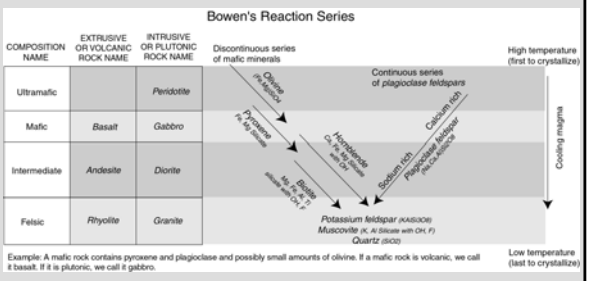
		Plagioclase (Na)	Hornblende	Biotite
		NaAlSi3O8	CaNaFe2Mg2Al3Si6O22(OH)2	KMgFe2AlSi3O10(OH)2
white	Si	3	6	3
green	Al	1	3	1
yellow	K			1
lilac	Ca		1	
red	Fe		2	2
orange	Mg		2	1
light blue	OH		2	2
blue	Na	1	1	
black	P, Mn, Ti			

		K-spar	Muscovite	Quartz
		KAlSi3O8	KAl3Si3O10(OH)2	SiO2
white	Si	3	3	1
green	Al	1	3	
yellow	K	1	1	
lilac	Ca			
red	Fe			
orange	Mg			
light blue	OH		2	
blue	Na			
black	P, Mn, Ti			

Magma Evolution Activity

STAGE 1: Remove
10 Olivines
(*move them to their own area – imagine the bottom of the magma chamber – and keep them in 10 individual stacks. Do same for rest of stages.*)

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

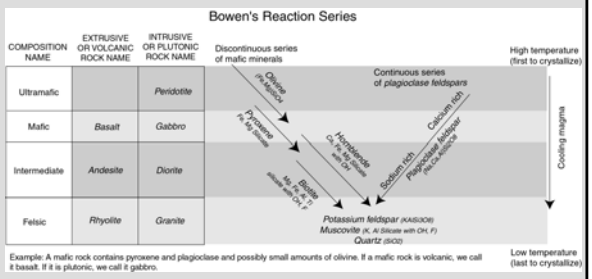
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Primitive Magma	%	Magma after stage 1	%
Si	200	50	190	51
Al	61	15	61	16
K	8	2	8	2
Ca	26	6	26	7
Fe	42	10	32	9
Mg	35	9	25	7
OH	17	4	17	5
Na	12	3	12	3
P, Mn, Ti, Au..	1	0	1	0
TOTAL	402	100	372	100

Magma Evolution Activity

STAGE 2: Remove
5 Olivines
5 Ca Plagioclase

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

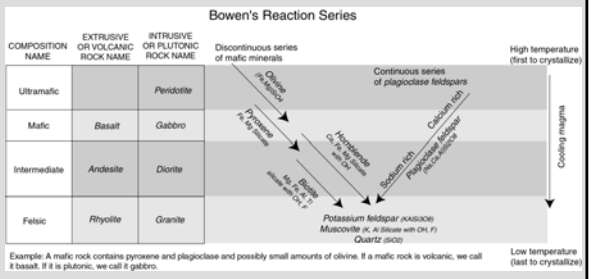
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 1	%	Magma after stage 2	%
Si	190	51	175	53
Al	61	16	51	15
K	8	2	8	2
Ca	26	7	21	6
Fe	32	9	27	8
Mg	25	7	20	6
OH	17	5	17	5
Na	12	3	12	4
P, Mn, Ti, Au..	1	0	1	0
TOTAL	372	100	332	100

Magma Evolution Activity

STAGE 3: Remove
3 Olivines
3 Ca Plagioclase
3 Pyroxenes

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

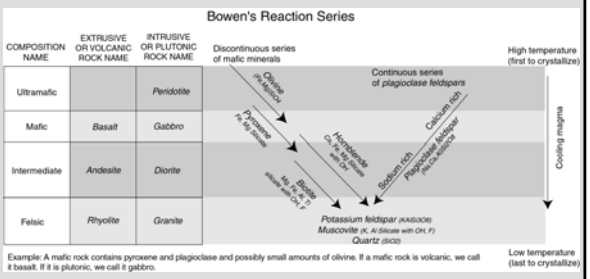
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 2	%	Magma after stage 3	%
Si	175	53	160	54
Al	51	15	45	15
K	8	2	8	3
Ca	21	6	15	5
Fe	27	8	24	8
Mg	20	6	14	5
OH	17	5	17	6
Na	12	4	12	4
P, Mn, Ti, Au..	1	0	1	0
TOTAL	332	100	296	100

Magma Evolution Activity

STAGE 4: Remove
3 Ca Plagioclase
3 Pyroxenes
1 Magnetite
1 Na Plagioclase

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

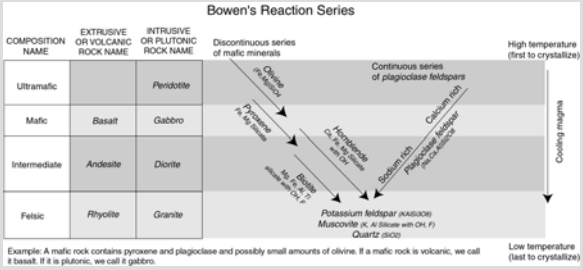
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 3	%	Magma after stage 4	%
Si	160	54	145	56
Al	45	15	38	15
K	8	3	8	3
Ca	15	5	9	3
Fe	24	8	21	8
Mg	14	5	11	4
OH	17	6	17	7
Na	12	4	11	4
P, Mn, Ti, Au..	1	0	1	0
TOTAL	296	100	261	100

Magma Evolution Activity

STAGE 5: Remove
3 Ca Plagioclase
1 Pyroxenes
1 Magnetite
3 Na Plagioclase
1 Hornblende

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

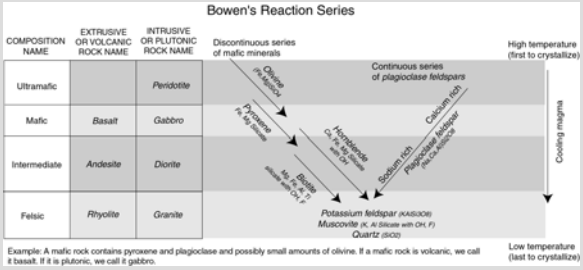
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 4	%	Magma after stage 5	%
Si	145	56	122	59
Al	38	15	26	13
K	8	3	8	4
Ca	9	3	4	2
Fe	21	8	16	8
Mg	11	4	8	4
OH	17	7	15	7
Na	11	4	7	3
P, Mn, Ti, Au..	1	0	1	0
TOTAL	261	100	207	100

Magma Evolution Activity

STAGE 6: Remove
1 Ca Plagioclase
1 Magnetite
3 Na Plagioclase
2 Hornblende
1 Biotite

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?



Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

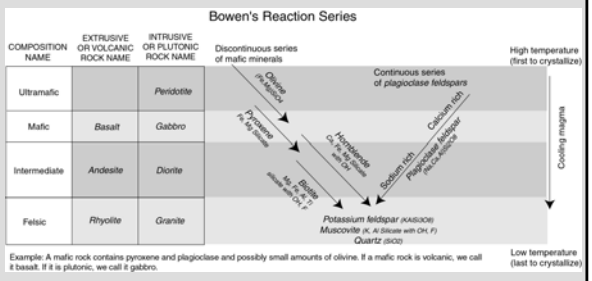
SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 5	%	Magma after stage 6	%
Si	122	59	96	69
Al	26	13	14	10
K	8	4	7	5
Ca	4	2	1	1
Fe	16	8	7	5
Mg	8	4	3	2
OH	15	7	9	6
Na	7	3	2	1
P, Mn, Ti, Au..	1	0	1	1
TOTAL	207	100	140	100

Magma Evolution Activity

STAGE 7: Remove
1 Magnetite
1 Na Plagioclase
1 Hornblende
1 Biotite
3 K Feldspar
1 Muscovite
50 Quartz

WHAT IS THE COMPOSITION OF ROCK FORMED FROM THIS COMBINATION OF REMOVED MINERALS?

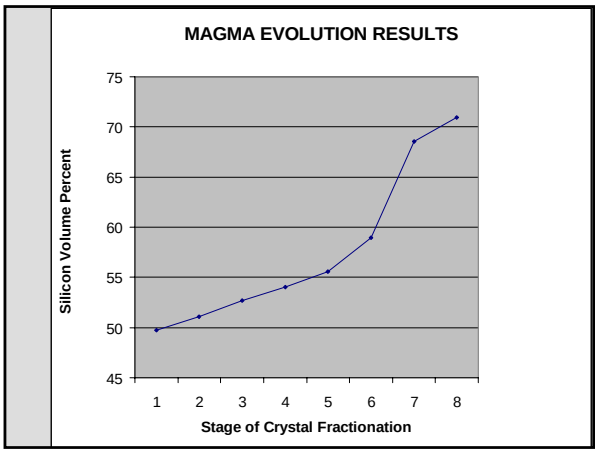


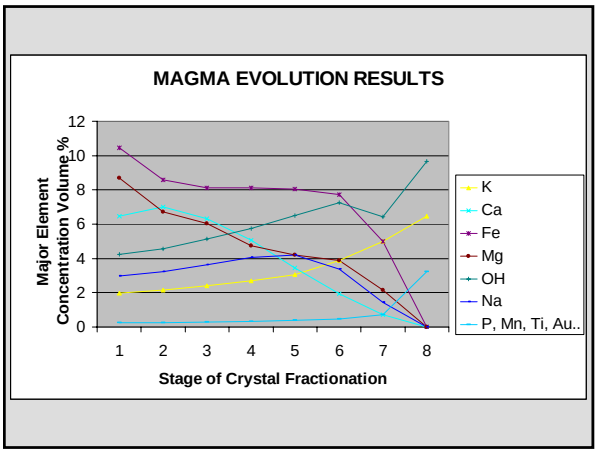
Magma Evolution Activity

AFTER MINERAL REMOVAL, WHAT IS THE NEW:

SILICON PERCENTAGE?
WATER PERCENTAGE?
GOLD PERCENTAGE?

	Magma after stage 6	%	Magma after stage 7	%
Si	96	69	22	71
Al	14	10	3	10
K	7	5	2	6
Ca	1	1	0	0
Fe	7	5	0	0
Mg	3	2	0	0
OH	9	6	3	10
Na	2	1	0	0
P, Mn, Ti, Au..	1	1	1	3
TOTAL	140	100	31	100


MAGMA EVOLUTION RESULTS
Silicon Volume Percent
75
70
65
60
55
50
45
1
2
3
4
5
6
7
8
Stage of Crystal Fractionation


MAGMA EVOLUTION RESULTS
Major Element Concentration Volume %
12
10
8
6
4
2
0
1
2
3
4
5
6
7
8
Stage of Crystal Fractionation
K
Ca
Fe
Mg
OH
Na
P, Mn, Ti, Au..