Introduction to chemistry of magma, and rock classification

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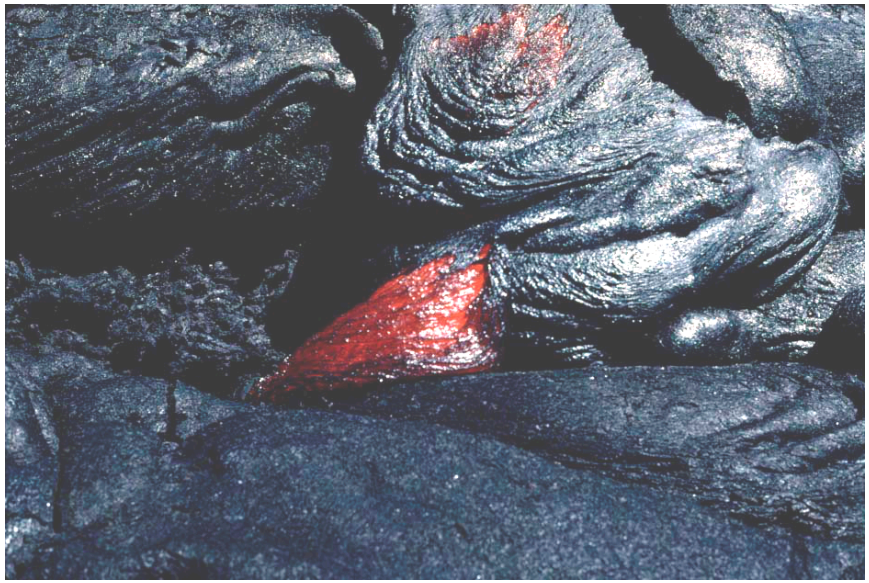
- Magma- naturally occurring high-temperature molten rock, consists of melt, and typically some combination of crystals and gas bubbles



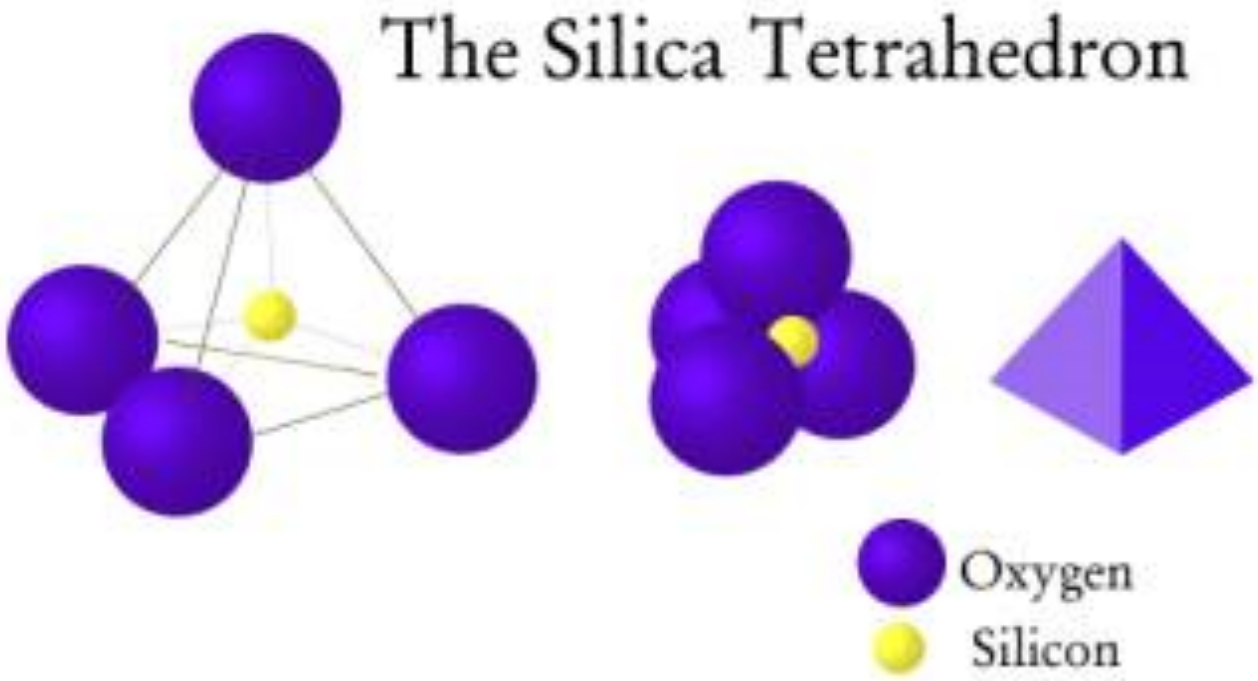
Chemical composition of magma

- Major elements >1 wt% of rock
- Minor element between 1-0.1 wt% of rock
- Trace element <0.1 wt%

Major/Minor elements in magma

- O
- Si
- Al
- Ca, K, Na, Fe, Ti, Mg, P, Mn

- H, S, Cl, F



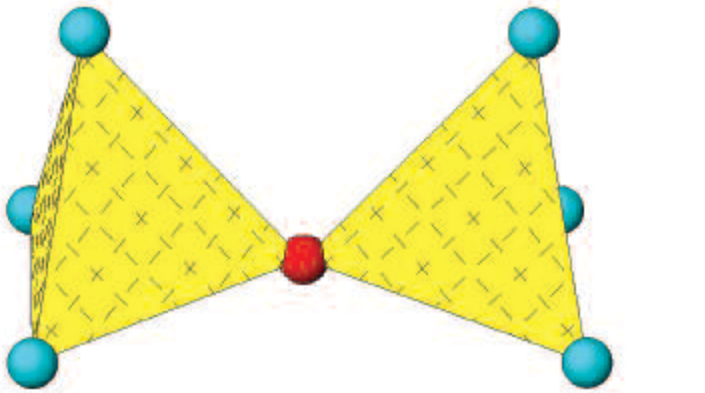
www2.bc.edu/.../lab1/default_files/image002.jpg

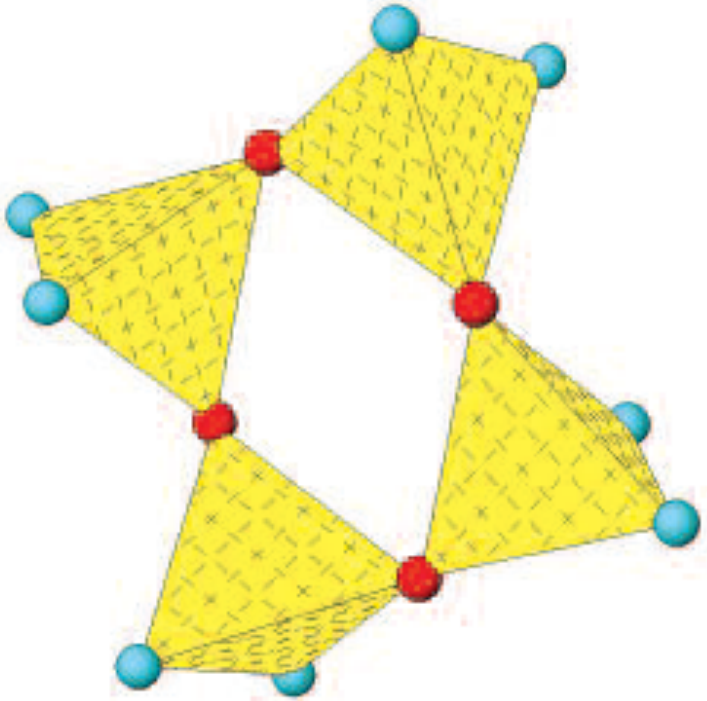
Element	Oxide (wt.%)	Element (wt. %)	Atomic %
O		48.9	63.2
Si	72.2	33.7	25.1
Ti	0.3	0.2	0.1
Al	12.6	6.7	5.2
Fe	4.4	3.1	1.2
Mg	0.6	0.4	0.3
Ca	2.1	1.5	0.8
Na	3.5	2.6	2.3
K	3.7	3.1	1.7

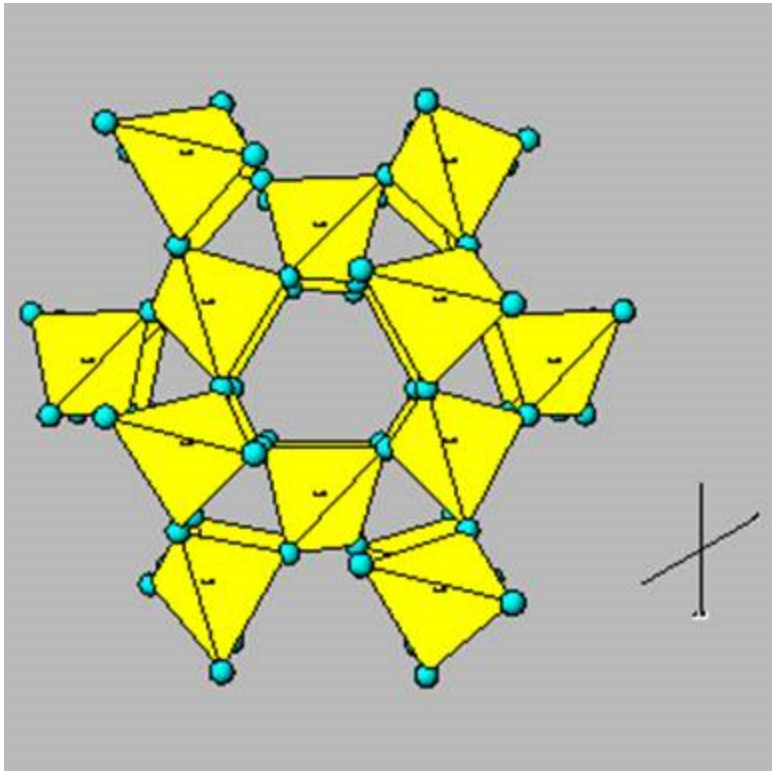
Melt composition

- O
- Si
- Al
- K
- Na
- Ca
- Fe
- Mg
- Ti
- P

Compound	Rhyolite	Basalt
SiO_2	73.2	49.2
TiO_2	0.2	2.3
Al_2O_3	14.0	13.3
FeO	1.8	12.0
MgO	0.4	10.4
CaO	1.3	10.9
Na_2O	3.9	2.2
K_2O	4.1	0.5
P_2O_5	0.1	0.2



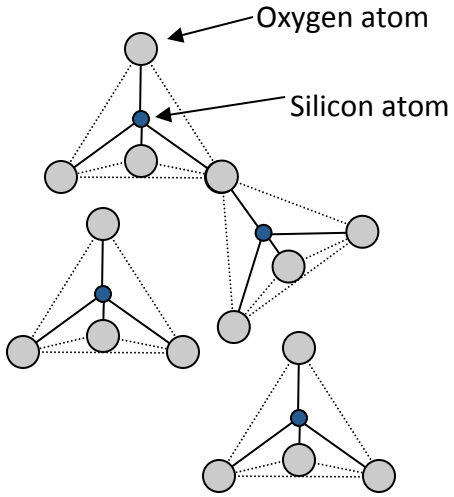




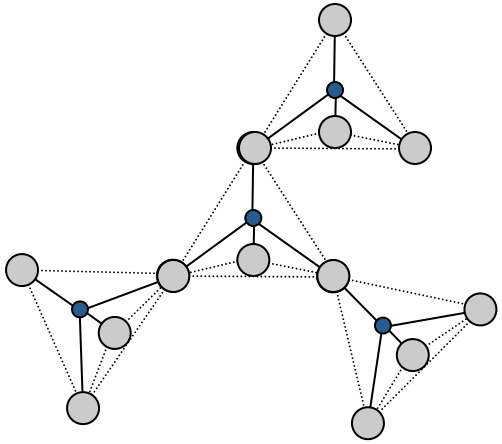
http://www.cnr.berkeley.edu/classes/espm-121/image002.jpg

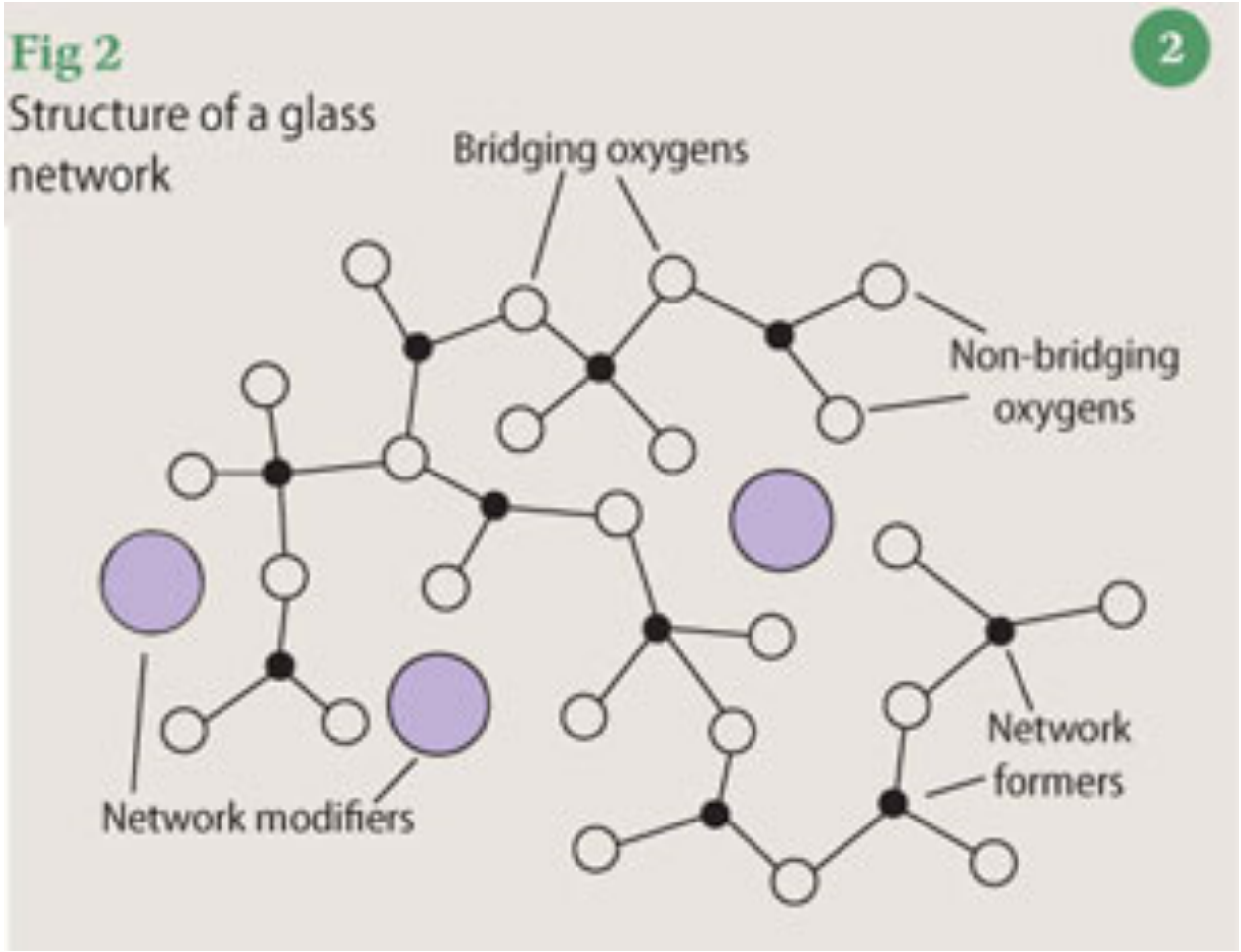
From Calas et al., 2006

Basalt configuration



Rhyolite configuration





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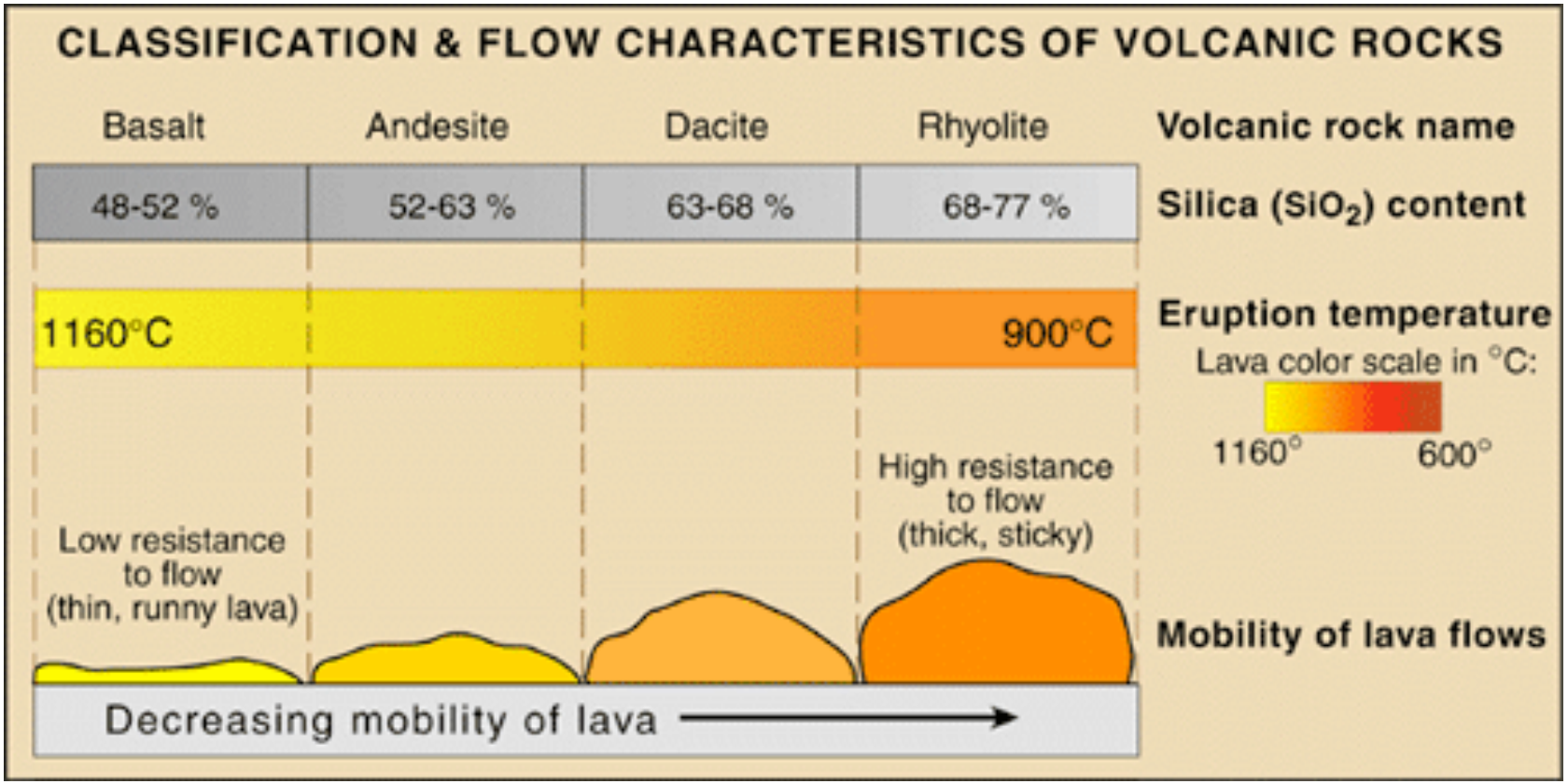
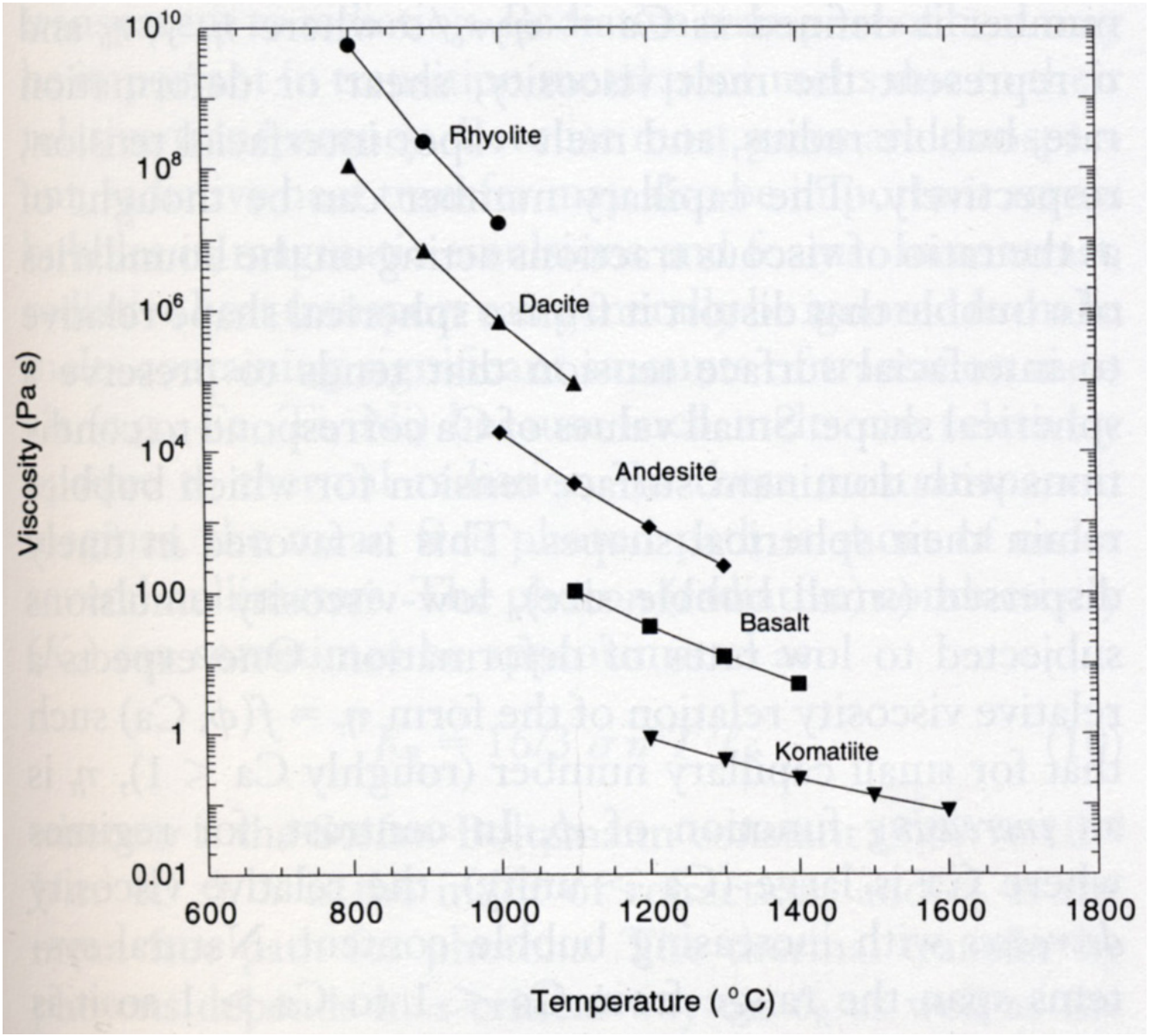


https://www.e-education.psu.edu/geosc30/node/720

Viscosity- Resistance to flow

Material	Viscosity (Pa s)	Wt% SiO_2	Temp. (°C)
Water	1.002×10^{-3}	–	20
ASE 30 motor oil	2×10^{-1}	–	20
Kimberlite	10^{-1}–1	30–35	~1000
Komatiite	10^{-1}–10	40–45	1400
Ketchup	$\sim 5 \times 10$	–	20
Basalt	$10–10^{2}$	45–52	1200
Peanut butter	$\sim 2.5 \times 10^{2}$	–	20
Crisco® shortening	2×10^{3}	–	20
Andesite	$\sim 3.5 \times 10^{3}$	~58–62	1200
Silly Putty®	$\sim 10^{4}$		
Tonalite 6% H_2O	$\sim 10^{4}$	65	950
Rhyolite	$\sim 10^{5}$	~73–77	1200
Granite 6% H_2O	$\sim 10^{5}$	75	750
Rhyolite	$\sim 10^{8}$	~73–77	800
Average mantle	10^{21}	–	–

From Philpotts and Ague, Igneous and Metamorphic Petrology, 2009

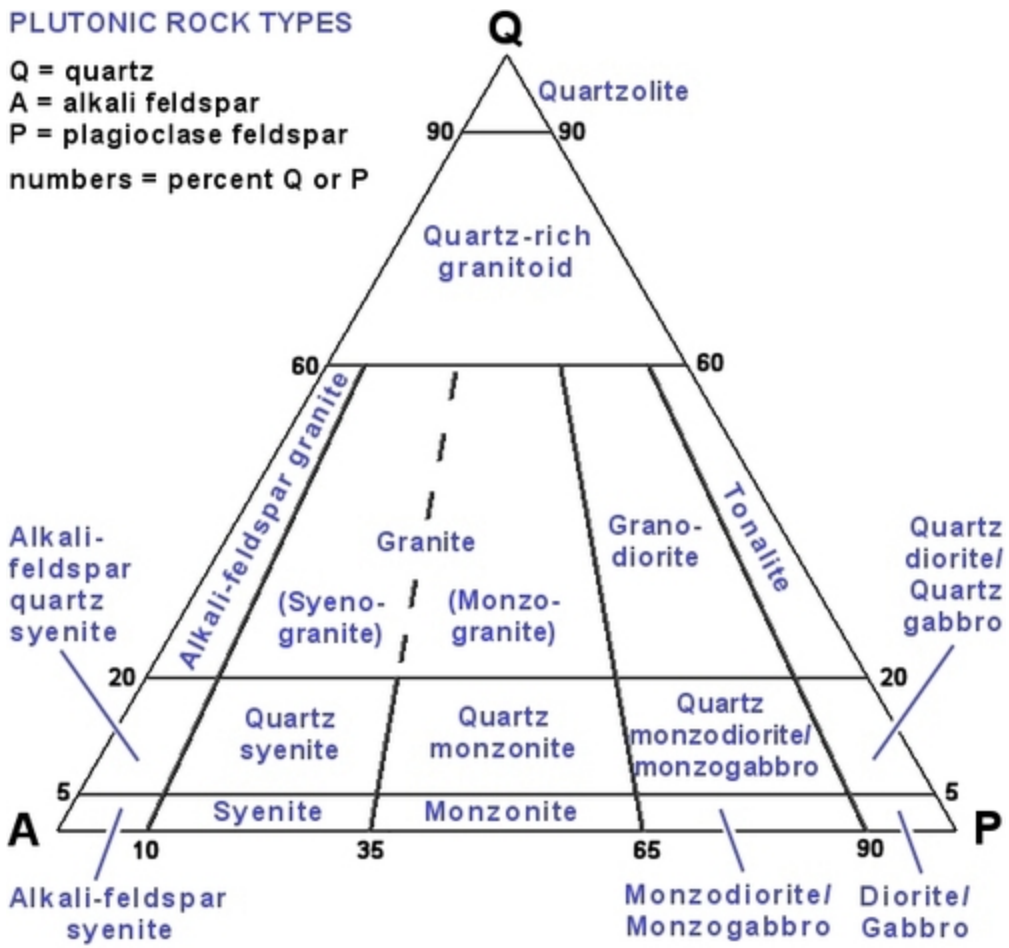


Spera et al., 2000

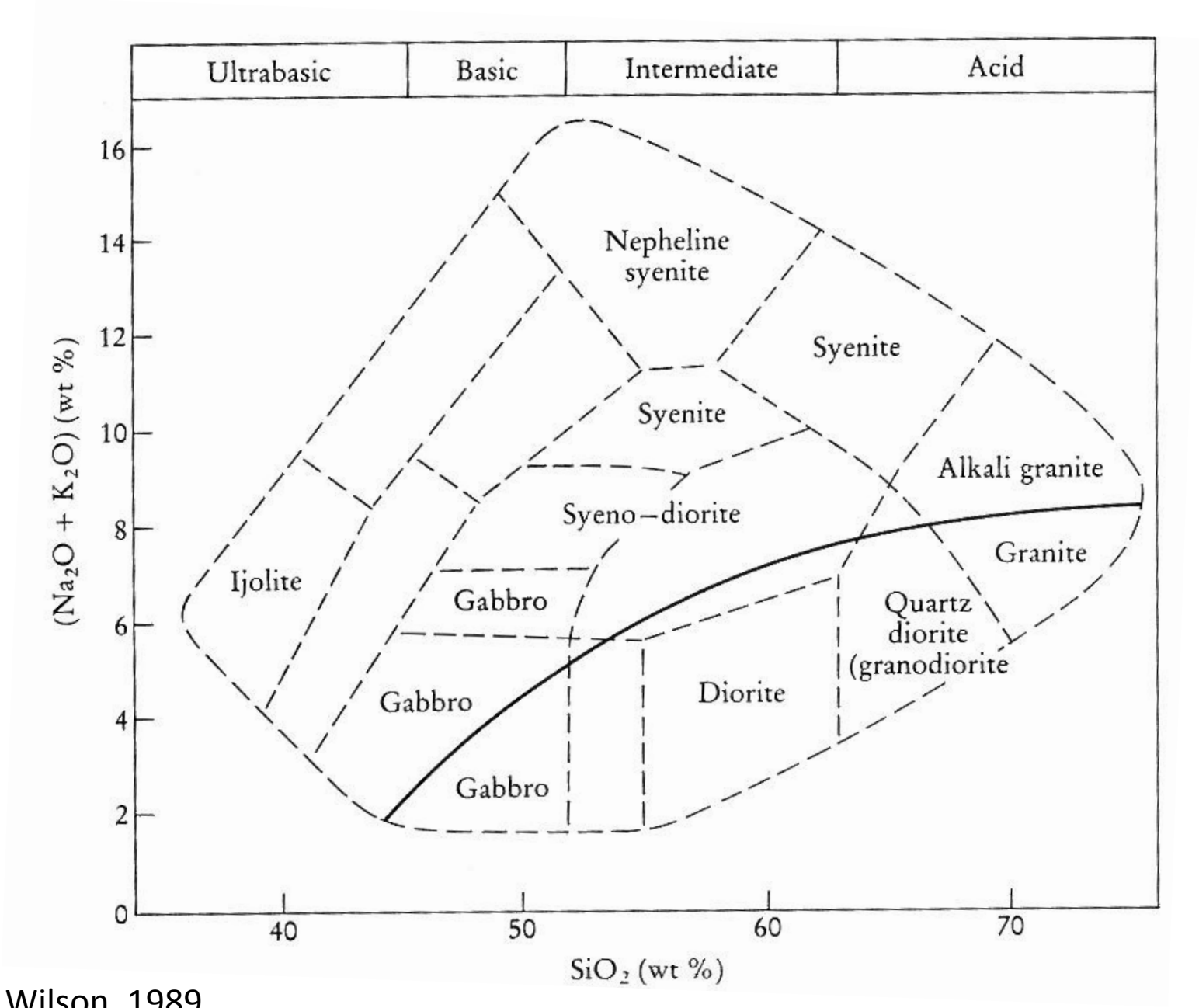
Classification of volcanic and plutons rocks

Why is it important?

Mineralogical classification of plutonic rocks

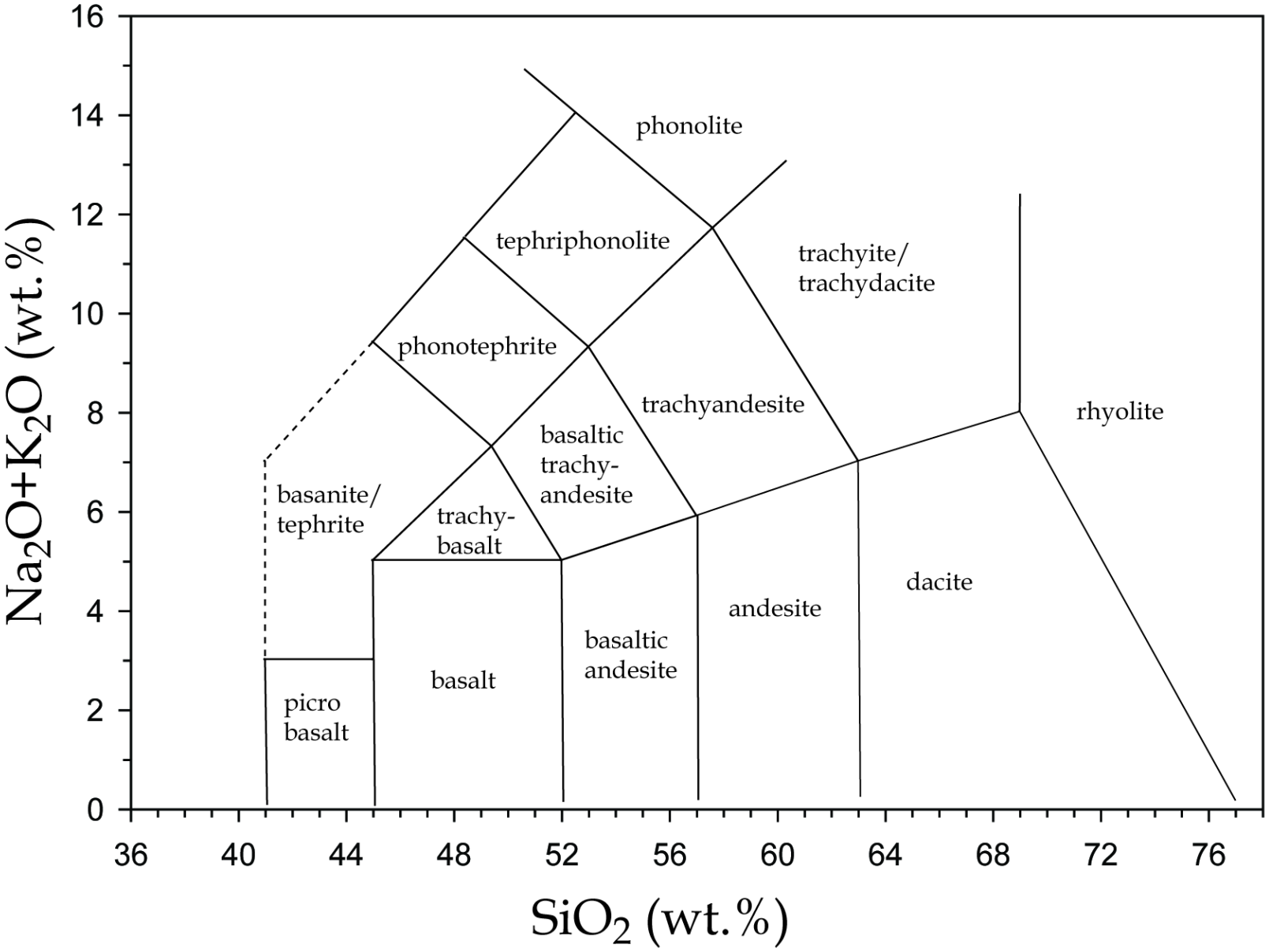


http://z.about.com/d/geology/1/7/M/N/1/600QAPplutonic.jpg



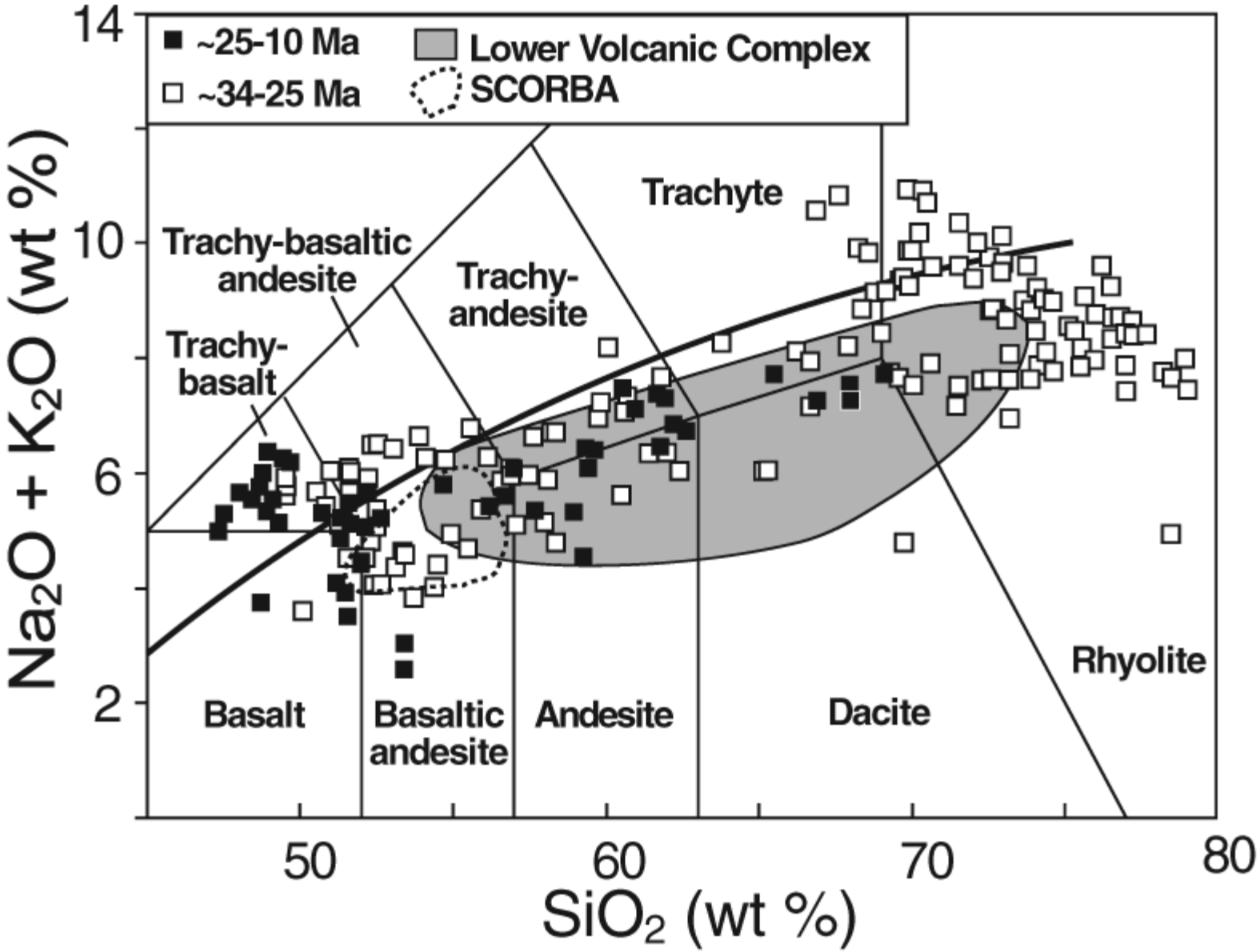
From Wilson, 1989

Chemical classification of volcanic rocks



Alkaline- high Na+K with respect to SiO_2. Feldspathiods in norm.

Peralkaline- $Al_2O_3 < (Na_2O + K_2O)$. Contain alkali pyx or amphibole



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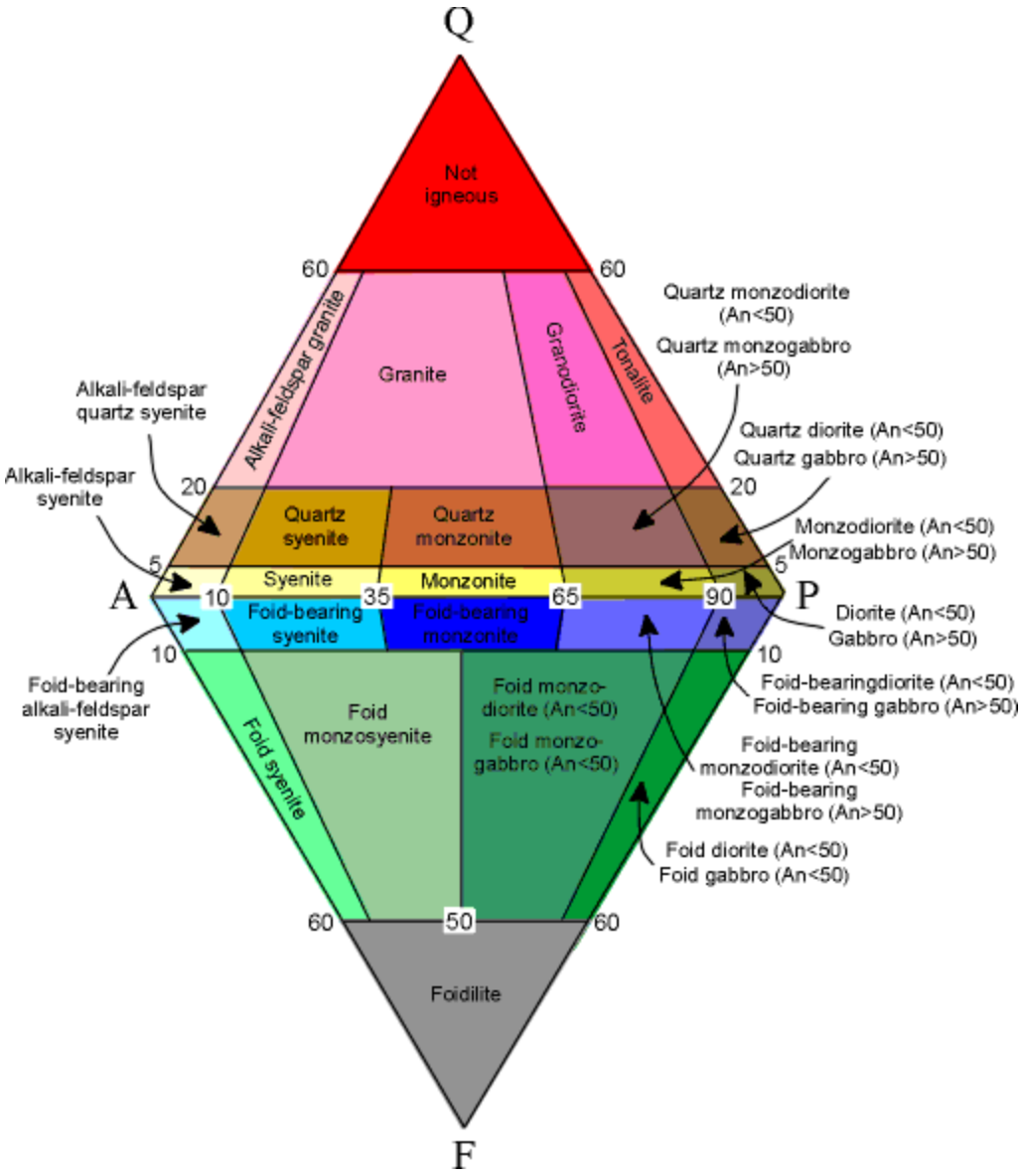

http://geology.csupomona.edu/alert/igneous/iugsclass.gif