SILICON/ROCK CYCLE FRAMEWORK
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in or from	**Location**	**Driving force**	*drives*	**Process**	*is*	**Explanation of process**	**Help ideas and connections**
Quartz (**Si**-O)	surface	chemical disequilibrium		weathering		Other minerals breakdown freeing the quartz from the rock	The Si) bonds in quartz are very strong so it does not dissolve.
Quartz (**Si**-O)	surface	gravity		mechanical erosion		movement of particles by water and occasionally by wind or ice.	Water moves much more material than ice and wind.
Bed load Quartz (**Si**-O)	rivers and ocean currents	gravity		transportation		particles move along the bottom	Sand size quartz grains hop along the bottom, pushed by currents
Quartz sand (**Si**-O)	rivers and ocean currents	gravity		deposition		as water movement slow particles settle to the bottom and stop moving	You might think of the sandy bottom along the shores of Lake Michigan
Sandstone Bed load Quartz (**Si**-O)	surface to subsurface	gravity		lithification/ compaction		Particles are pressed or cemented together changing loose grains into rock	Sand becomes the sedimentary rock sandstone
Meta-sandstone Bed load Quartz (**Si**-O)	subsurface	chemcial disequilibrium heat/ pressure		metamorphism		minerals grow	Sedimentary rock becomes metamorphic rock
Magma Quartz melts to fom Si^{4+} ions in magma	subsurface	chemcial disequilibrium heat / water		martial melting		bonds are broken along boundaries of crystals	Under most conditions (P,T, H_2O, only some minerals in a rock melt.
Magma Si^{4+} ions in magma	subsurface	gravity		buoyant rising		Magma is less dense than the surrounding rocks	The is analogous to a hot air balloon rising in the atmosphere
Magma Si^{4+} ions in magma	subsurface /surface	chemcial disequilibrium heat/pressure /water		crystallization		mineral chemically precipitate from the magma	Under most conditions (P,T, H_2O, only some minerals precipitate
Quartz (**Si**-O)	subsurface to surface	gravity		uplift		rocks slowly float to the surface as overburden is eroded	Minerals that form at high temperature and pressure are found at the earth's surface

Calcium/rock cycle

in or from	**Location**	**Driving force**	*drives*	**Process**	*is*	**Explanation of process**	**Help ideas and connections**
Feldspar (K-Na-**Ca**-Al-Si-O)	surface	chemical disequilibrium		weathering		Feldspar + $CO_2(g)$ + $H_2O(l) \Leftrightarrow K^+ + Na^+ +$ **Ca^{2+}** ions in solution+ Al	Feldspar partially dissolve to give ions in solution plus solids (clays)
Clay (K-Na-**Ca-**Al-Si-O)	surface	gravity		mechanical erosion		Movement of ions in water	**Ca^{2+}** is the most common positively charged ion in fresh, natural waters
dissolved load ions (K-Na-**Ca**-HCO_3^-, Cl^-	rivers and ocean currents	gravity		transportation		Ions carried by currents	Ions in solution are invisble.
skeletons of marine organism **Ca**CO3	ocean	biosynthesis		biochemical precipitation		Ca^{2+}+ $HCO_3^- \Leftrightarrow$ $CaCO_3(s)$ + $CO_2(g)$ + H_2O	This is an important part of the carbon cycle
skeletons of marine organism **Ca**CO3	sea floor	gravity		deposition		Skeletons composed of calcite ($CaCO_3$) accumulate on the seafloor	Huge reefs deposits in warm shallow seas and thin beds on deep ocean floors
limestone **Ca**CO3	surface to subsurface	chemcial disequilibrium		cementation /lithification		Ca^{2+}+ $HCO_3^- \Leftrightarrow$ $CaCO_3(s)$ + $CO_2(g)$ + H_2O	Calcite precipitates between skeletal fragments binding them together
marble **Ca**CO3	subsurface	chemcial disequilibrium heat/ pressure		metamorphism		Minerals grow and change structure	Sedimentary rock becomes metamorphic rock
CaSiO_3 Calcium silicate	subsurface	chemcial disequilibrium heat/ pressure		metamorphic degassing		$CaCO_3$ + SiO_2 $\Leftrightarrow CaSiO_3$ + CO_2	An important process for returning carbon to the atmosphere
CaSiO_3 Calcium silicate	subsurface to surface	gravity		uplift		Rocks slowly float to the surface as overburden is eroded	Minerals that form at high temperature and pressure are found at the earth's surface
CaSiO_3 Calcium silicate	subsurface/ mantle	chemcial disequilibrium heat/ pressure/ water		partial melting		bonds are broken along boundaries of crystals	Under most conditions (P,T, H_2O, only some minerals in a rock melt.
Magma **Ca-**) ions		chemcial disequilibrium heat/ pressure/ water		crystallization		mineral chemically precipitate from the magma	Under most conditions (P,T, H_2O, only some minerals preci

Aluminum/rock cycle

in or from	**Location**	**Driving force**	*drives*	**Process**	*is*	**Explanation of process**	**Help ideas and connections**
Feldspar (K-Na-Ca-**Al**-Si-O)	surface	chemical disequilibrium		weathering		feldspar + $CO_2(g)$ + $H_2O(l) \Leftrightarrow K^+ + Na^+ + Ca^{2+}$ + **Al** in clay minerals	Feldspar partially dissolve to give solids(clays) plus ions in solution.
Clay (K-Na-Ca-**Al**-Si-O)	surface	gravity		mechanical erosion		movement of particles by water and occasionally by wind or ice.	Water moves much more material than ice and wind.
suspended load clay (K-Na-Ca-**Al**-Si-O)	rivers and ocean currents	gravity		transportation		clays are carried in suspension while larger particles move along the bottom	Rivers often appear brown because of the suspended clays.
sediment clay (K-Na-Ca-**Al**-Si-O)	rivers and ocean currents	gravity		deposition		as water movement slow particles settle to the bottom	The suspended load deposits mud
Shale Sedimentary Clays (K-Na-Ca-**Al**-Si-O)	surface to subsurface	gravity		lithification/ compaction		Particles are pressed together changing loose grains into rock	Mud becomes the sedimentary rock shale
Slate Mica (K-Na-Ca-**Al**-Si-O)	subsurface	chemcial disequilibrium heat/ pressure		metamorphism		minerals grow and change structure	Sedimentary rock becomes metamorphic rock
Gneiss Mica (K-Na-Ca-**Al**-Si-O)	subsurface	chemcial disequilibrium heat/ pressure		metamorphism		minerals grow and change structure	As mica grows it often becomes segregated into ¼-5 inch mica rich and mica poor bands
Mica (K-Na-Ca-**Al**-Si-O) Feldspar (K-Na-Ca-**Al**-Si-O)	subsurface /mantle	chemcial disequilibrium heat/pressure /water		partial melting		bonds are broken along boundaries of crystals	Under most conditions (P,T, H_2O, only some minerals in a rock melt.
Magma **Al-**O ions	subsurface /mantle	chemcial disequilibrium heat/pressure /water		crystallization		mineral chemically precipitate from the magma	Under most conditions (P,T, H_2O, only some minerals preci
Feldspar (K-Na-Ca-**Al**-Si-O)	subsurface to surface	gravity		uplift		rocks slowly float to the surface as overburden is eroded	Minerals that form at high temperature and pressure are found at the earth's surface