How and Where Gems Form, Part 1 of 2

A specific, and unlikely, combination of five factors account for how and where gems form. Temperature, pressure, space, chemical elements and time are required for the formation of each kind of gem. This is why gems are, in general, rare—but some are rarer than others.

Gems, in nature form from: 1) solutions by precipitation, 2) melts by crystallization, or 3) vapors by condensation.

Solution/Precipitation Gem Formation

Both near-surface cooler waters, and warmer waters from lower depths in the Earth can dissolve certain minerals from rocks or sediments, and carry, mix, and concentrate them until conditions change, ultimately precipitating them as solids (crystals or amorphous materials).

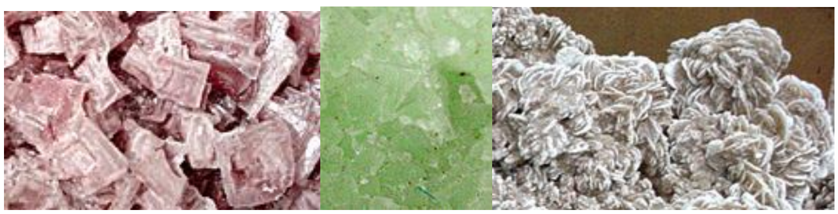
Near surface environments: Near surface waters, like rainwater, move down or up through soil or rock as the local cycles of precipitation and evaporation dictate. Such water has carbon dioxide from the air dissolved in it, which creates a weak acid solution (carbonic acid) in which many minerals are soluble. If the environment contains sandy soils or sandstone rock, then silica will be dissolved and certain silicate gems such as aggregate quartzes (e.g., agates or amorphous opals) may form as the water evaporates.

Commonly, layered or banded patterns are seen in the agates, indicating cycles of formation from waters of slightly different chemistries. The botryoidal habit is also frequently seen in gems formed under near surface conditions. Likewise, ocean water or other brines can evaporate as climate changes leaving behind dissolved minerals like halite (the mineral name for sodium chloride, table salt). Other waters containing sulfur may evaporate and leave behind sulfate minerals like gypsum.

If the rocks or soils contain aluminum and copper in addition to silica, then copper containing minerals like azurite, malachite and turquoise may form.

[Near surface silicate gems: agate cabochon showing layered structure, botryoidal carnelian, precious opal in rock seam, common opal nodule]

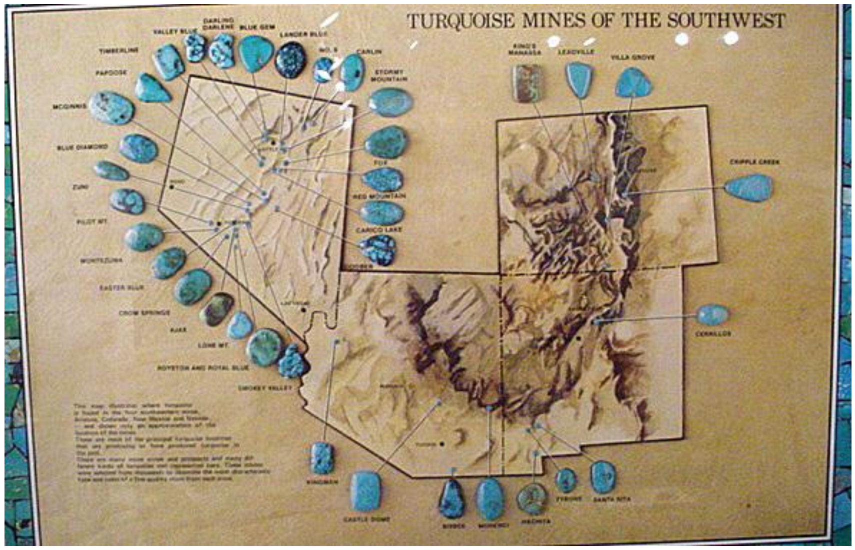
[Amethyst stalactite: note layered structure of both aggregate and single crystals]



[Minerals from briny evaporates: "cranberry halite" from Nevada, green halite from Australia (color is due to pigments from crustaceans and microorganisms that lived in the salty water), gypsum "roses": Images courtesy of Las Vegas Jewelry and Mineral]

[Turquoise bearing rock, from Nevada: Image courtesy of Las Vegas Jewelry and Mineral, rare occurrence of single turquoise crystals from Virginia 50x, malachite, turquoise and chrysocolla veins in an Arizona rock: Image courtesy of Dr. Barb Dutrow, slice of a malachite and chrysocolla stalactite: Image courtesy of www.barlowsrocks.com, azurite crystals from Utah]

Think about where you imagine miners finding agates, opals, and copper minerals. You probably already know that the best deposits occur in rocky, sandy areas with an arid or semiarid climate. Most of the world's precious opal, for example, comes from the Australian desert, and the Western USA and Mexico are well known sites of turquoise and agate deposits.

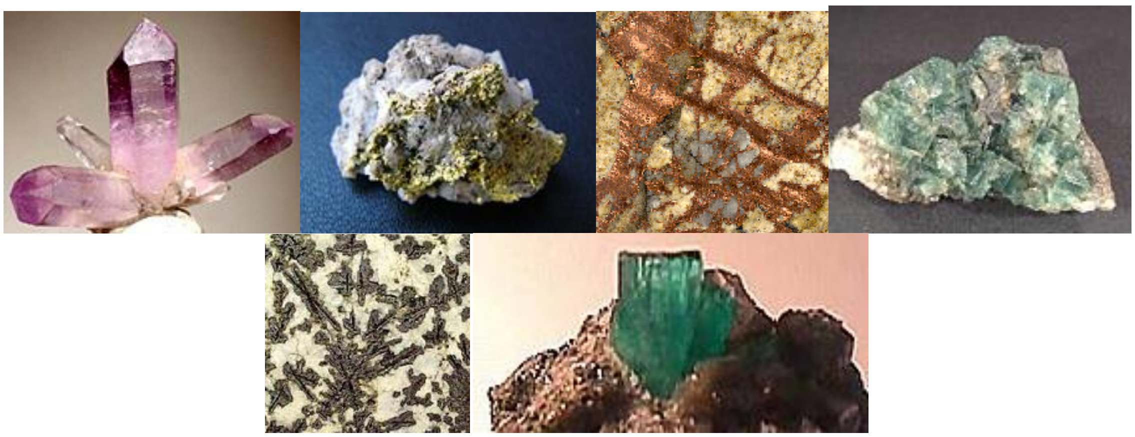


[Map of some of the major turquoise mines in the Southwest (photo taken at the Las Vegas Natural History Museum)]

Petrifaction: Sometimes the hard, organic remains of plants such as wood or cones, or the bones or shells of animals are buried in lava or sediments before they can decay. Such burial restricts oxygen supply, and decomposition processes slow to a snail's pace. Silica laden waters can, ever so slowly, fill and replace any cavities or structures that are present with agate or opal, preserving a replica of the original form in solid rock. Many fossils are the result of this process, known as *petrifaction*.

[Examples of petrifaction: slice of fossil palmwood: Image courtesy of www.barlowsrocks.com, cabochon of fossil palmwood from Texas, fragments of fossilized dinosaur eggshell, pendant with red spinel, fire agate and fossilized dinosaur eggshell, fossil wood slices from Oregon: Image courtesy of Las Vegas Jewelry and Mineral, opalized clam fossil (opal solution filled the cavity of the clam shell and solidified before the shell decayed. Remnants of the fossil shell were then cut and polished away, revealing a perfect "cast" of the original shape]

Deeper Environments: Waters from deeper in the Earth are often heated from contact with hot rock, and are sometimes highly acidic or alkaline, making an even better solvent for more types of minerals. Environments where water of this type is found are termed *"hydrothermal"*. Usually, rates of cooling and/or evaporation are slower than in near surface environments giving time for single, larger crystals to form. Many of the world's highest quality mineral specimens and metal ores have come from such hydrothermal sources. Emeralds, rock crystal quartz, amethyst, and fluorite are gems commonly formed when hydrothermal fluids solidify (as veins or crystals) in the cracks or pockets within rocks, or between rock layers.



[Hydrothermal amethyst crystals from Mexico: Image courtesy of www.irocks.com, gold veins in quartz: Image courtesy of California Geological Survey, native copper veins in Arizona rock: Image courtesy of Dr. Barb Dutrow, hydrothermal fluorite crystals, dendritic silver in quartz: Image courtesy of www.irocks.com, Natural hydrothermal emerald crystals in matrix: Image courtesy of www.yourgemologist.com]

Geodes: Cavities dissolved into sedimentary rock, or gas pocket cavities in igneous rock are prime sites where crystallization from hydrothermal solutions occur. The results, known as geodes, usually contain agate or quartz, and are one of the favorite finds of rock hounds.

[Small quartz geodes, huge amethyst "cathedrals": Images courtesy of Las Vegas Jewelry and Mineral, the outside and inside of a rare azurite geode from Arizona]

Source: http://www.bwsmigel.info/lesson10/de.gem.formation.html
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