GEMS

Dr Raghuveer

KVG Ayurveda Medical College Sullia

What is a Gem?

- Gems have been part of human history.

- very early gems were generally of organic materials.
- Examples include (left-right) coral, amber
  - most gems used today are inorganic minerals.
  - early crystal gems were probably derived from alluvial sources.
  - Gems are often those minerals that are resistant to chemical weathering. They are commonly concentrated in stream beds and beach sands in what are known as **alluvial deposits**.

GEM

- A **gem** is a **naturally occuring** material **desirable** for its **beauty**, **valuable** in its **rarity**, and sufficiently **durable** to give lasting pleasure.

- It should be **naturally occurring**, but it need not be crystalline.
- **Beauty** is determined by brilliance, color and sparkle
- A gem should be **durable** against heat and common household chemicals.
- It should not be easily scratched or broken.
- Brittleness is a measure of the gem's tendency to crack or cleave.

Beauty

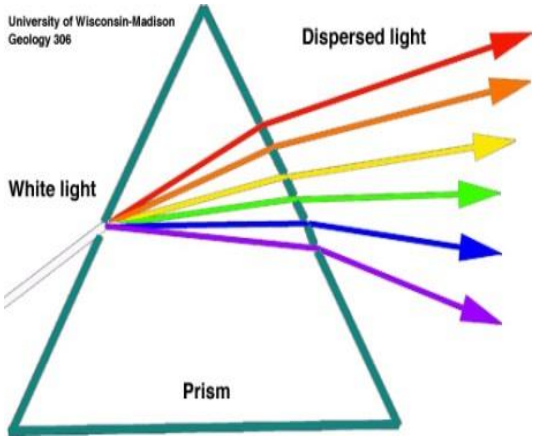
- Beauty of a gemstone is determined by brilliance, luster, fire and color (later lecture). The first three quantities depend on the cut of the stone.

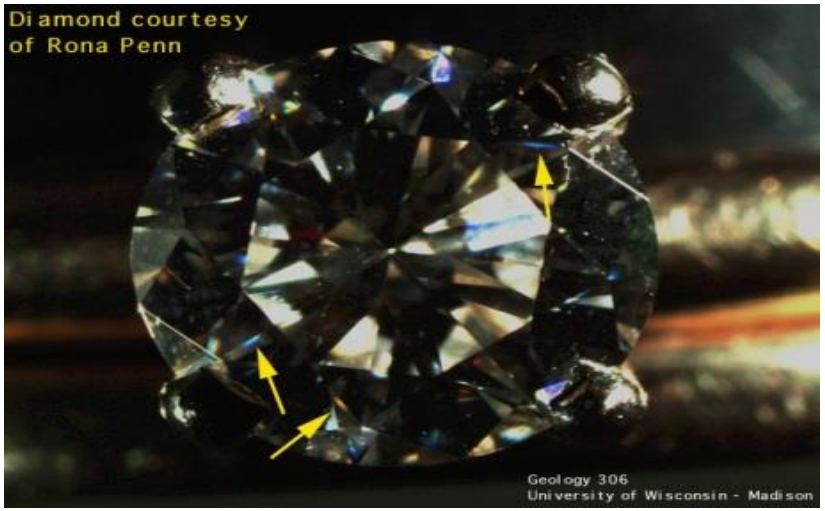
Luster

- Luster is a function of both the surface and the RI of the mineral itself.
- Terms used to describe luster include pearly, metallic, silky, vitreous, resinous, and waxy.
- Gem grading reports refer to "finish" or "polish" to describe how well polished the surface is.
- "Luster" is also used to describe how mirror=like the surface of a pearl is.

Fire

- "Fire" refers to the rainbow-like flashes of color seen in cut stones.
- Fire is especially obvious in diamonds.





Fire in diamonds

Durability

- Resistance to scratching: this is evaluated by consideration of gem hardness.
- If we compare two different minerals, for example diamond and quartz (the main ingredient in beach sand) we will find that quartz crystals are readily scratched by diamond but diamonds can not be scratched by quartz. Thus, diamond is much much harder than quartz.

Value

- The 4 factors that affect the value of a gemstone are easily remembered as the **"4 c's".**
- **COLOR** - Pleochroism
- **CLARITY**-flaws (crack, inclusions) decrease the value of a gemstone
- **CUT**-Poorly cut stones have much lower value
- **CARAT WEIGHT**-bigger is not always better, but for otherwise equal color, clarity, cut, the larger the stone will be more expensive

- 1 carat = 0.2 g
- 5 carat = 1 g
- Notice that the number of carats depends on density, so two different types of gems of the same size will normally be a different number of carats.

Organizations

- Many people turn to a professional organization such at The Gemological Institute of America (GIA) and American Gemological Laboratories (AGL) for the "final" determination, especially for more expensive stones.
- These organizations provide certificates that document the characteristics of individual gems.

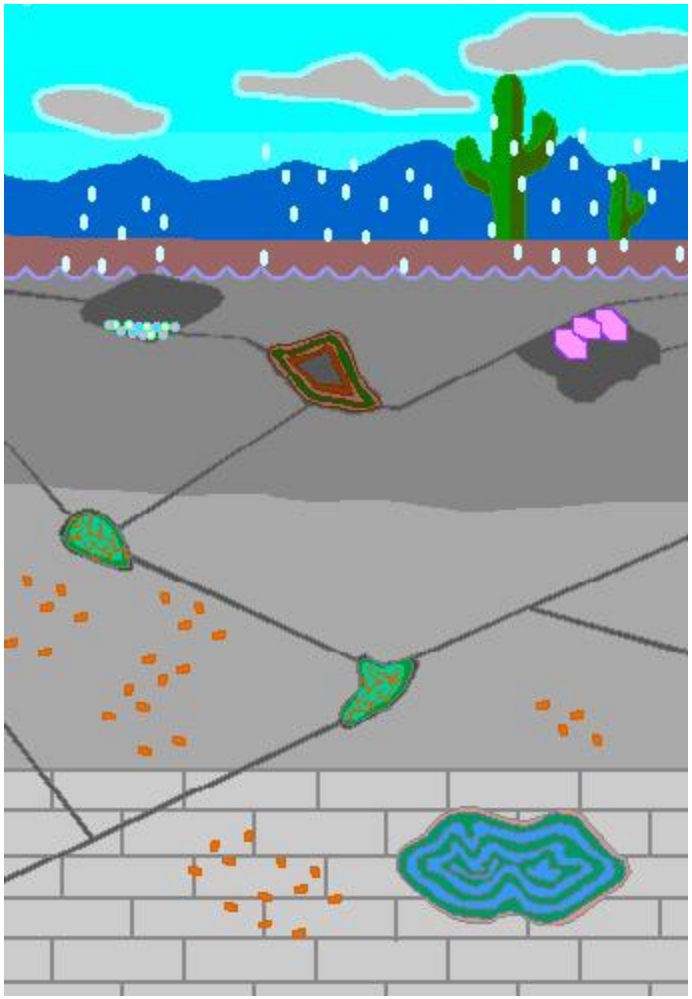
Formation of gem

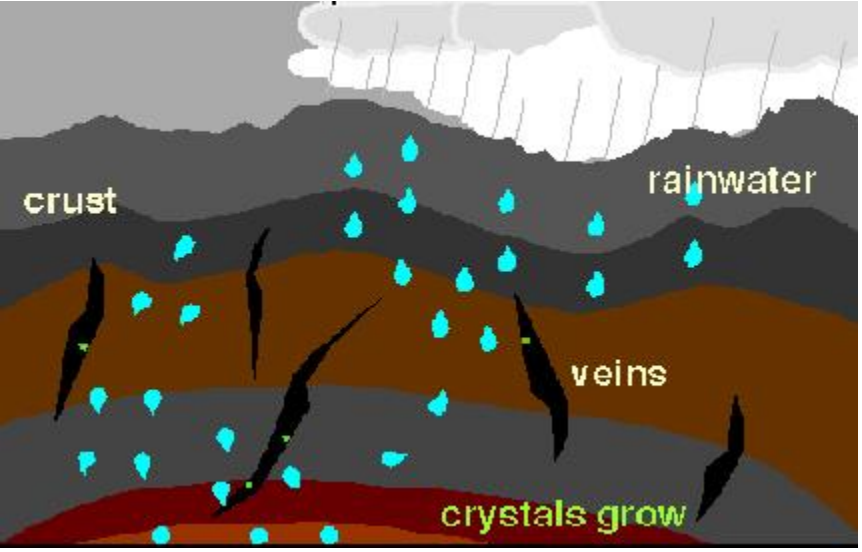
- Almost all gems are formed below the Earth's surface.
- Some are brought to the surface through mining Some are brought to the surface through earth processes (faulting, folding, large scale uplift, volcanism). These processes can move rock up from more than 400 km below the surface.

1. Formation from water near the Earth's surface

- Water near the Earth's surface interacts with minerals and dissolves them. The ability of these solutions to maintain elements in solution varies with physical conditions. If the solution conditions change (for example if the solution cools or evaporates), minerals will precipitate. A similar, familiar processes is formation of salt crystals by evaporation of sea water. The mineral that forms is determined by what the dissolved elements are. If the water has interacted with silica-rich rocks (e.g., sandstone), silica-rich minerals will form:
- Silica (SiO_2)-based minerals: amethyst (quartz); agate ; and the formation of opal. Of these, only opal is non-crystalline (ordered blobs of gel less than a micron in diameter).
- If the water has interacted with copper-rich rocks, copper minerals will form: Cu-bearing minerals: malachite and azurite; or turquoise.

- This picture shows formation of agate, amethyst, opal, turquoise, and malachite/azurite.
- Note the importance of alternating wet periods (when solutions are dilute and can dissolve a large amount of silica, copper, etc.) and dry periods (when solutions evaporate and minerals precipitate).





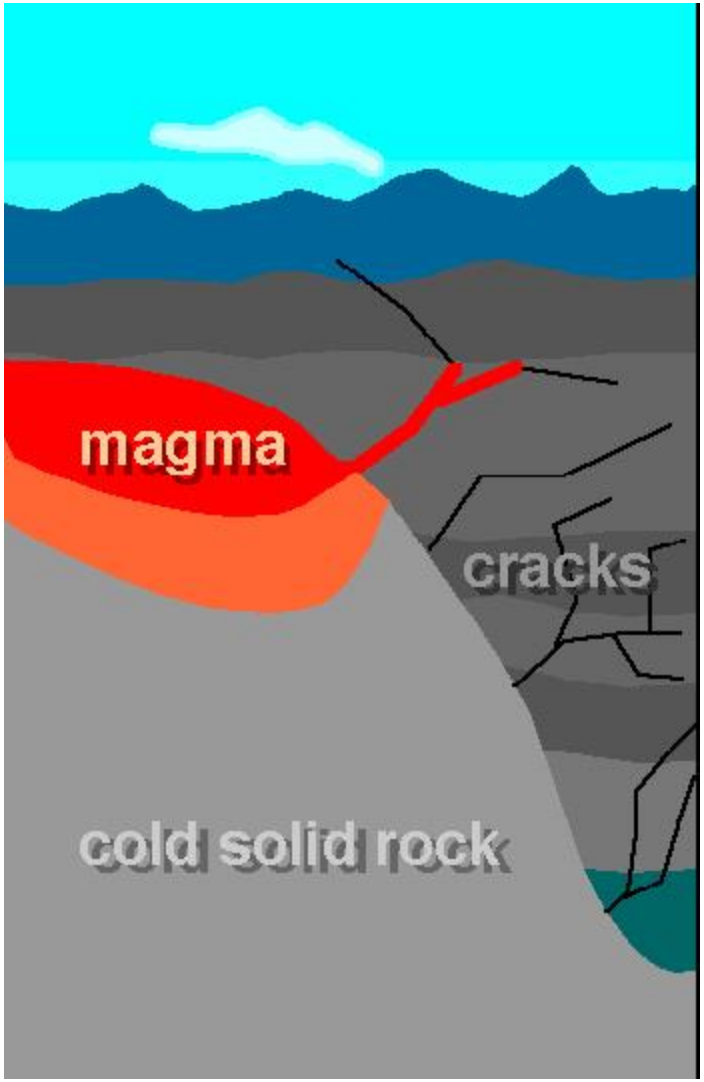
2. Hydrothermal deposits

- The formation of gems by **hydrothermal** processes is not dissimilar to formation of gems from water near the Earth's surface The solutions involve rain water and/or water derived from cooling magma bodies< Gems crystallize from solution when it encounters open spaces such as cracks. As a result, 'veins' of minerals fill preexisting cracks.
- Minerals such as beryl (e.g., emerald), tourmaline need unusual elements, and some of these, like beryllium (for beryl) or boron (for tourmaline) are derived from cooling molten rock (magma).

3. Pegmatites

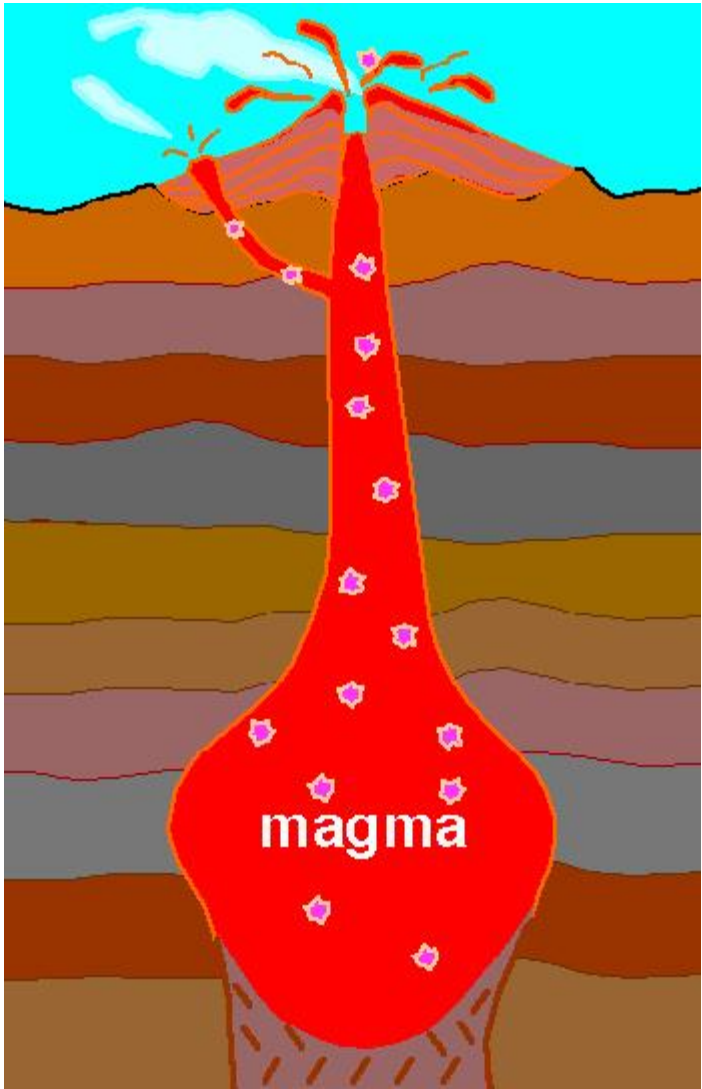
- Pegmatites are unusual magma bodies. As the main magma body cools, water originally present in low concentrations becomes concentrated in the molten rock because it does not get incorporated into most minerals that crystallize. Consequently, the last, uncrystallized fraction is water rich. It is also rich in other weird elements that also do not like to go into ordinary minerals.
- When this water-rich magma (also rich in silica and unusual elements) is expelled in the final stages of crystallization of the magma, it solidifies to form a **pegmatite**.
- The high water content of the magma makes it possible for the crystals to grow quickly, so pegmatite crystals are often large. Of course, this is important for gem specimens!
- When the pegmatite magma is rich in beryllium, crystals of beryl form.
- If magmas are rich in boron, tourmaline will crystallize.

- This picture shows formation of crystals such as emeralds and tourmaline in pegmatite bodies associated with cooling intrusive (magmatic) rocks



4. Magmatic gems

- Some gems crystallize in magmas or in gas bubbles (holes) in volcanic rocks. Examples include: zircon, topaz, ruby, etc.

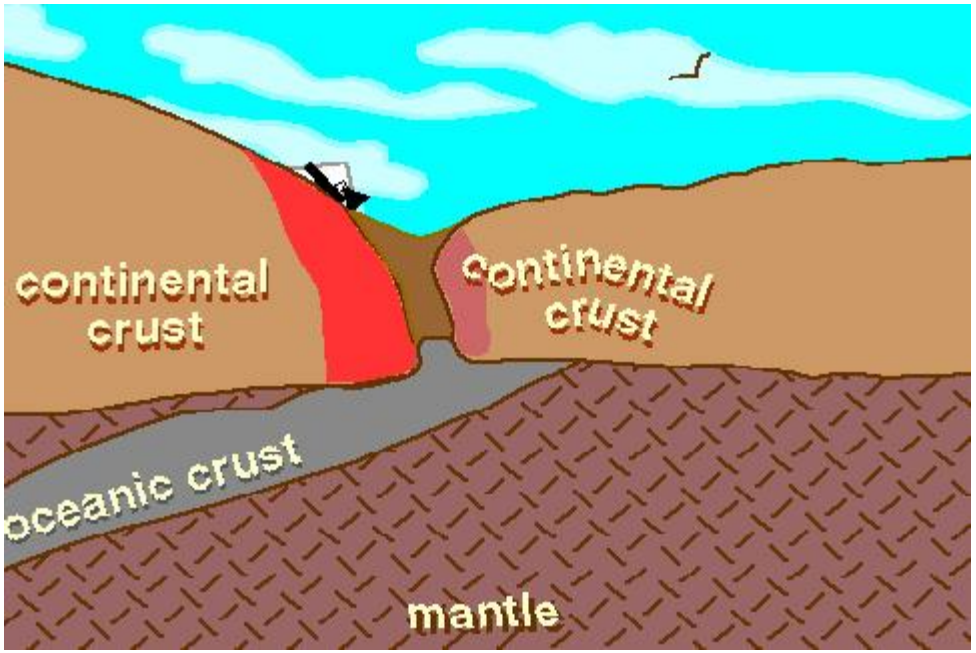


This pic shows formation of crystals such as ruby or zircon (pink crystals) and topaz in open cavities (e.g., holes made by gas bubbles) in volcanic rocks.

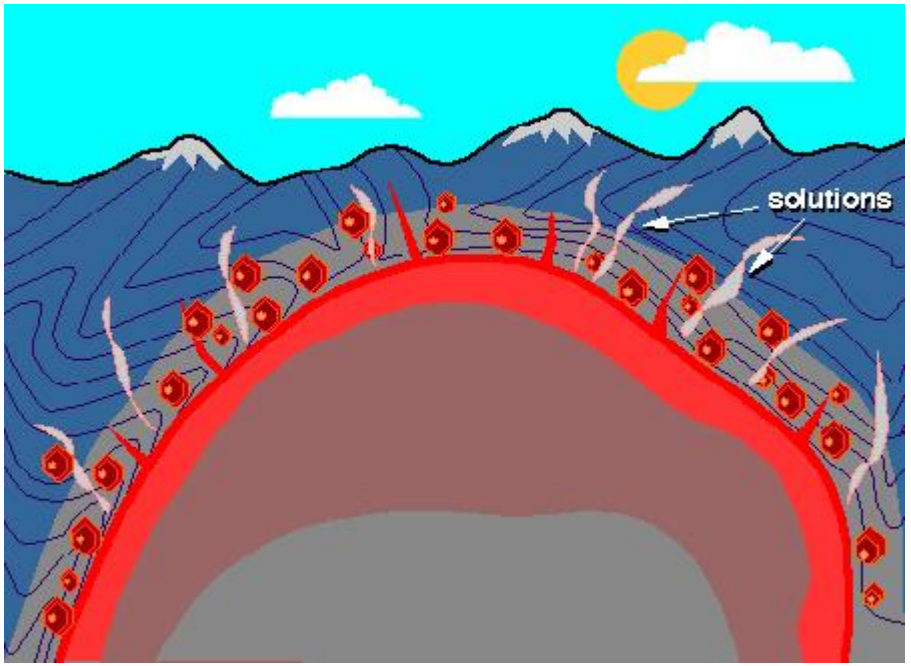
5. Metamorphic gems

- Metamorphic rocks are rocks changed by heat, pressure, and interaction with solutions.
- Regionally metamorphosed rocks: large volumes of rock that are buried and changed in response to increases in pressure and temperature.
- Minerals found in these rocks might include gems such as garnet and cordierite.

This pic shows metamorphism of rocks resulting from continent-continent collision associated with a subduction zone. Note the formation of large crystals such as garnet in the deformed, heated zone.



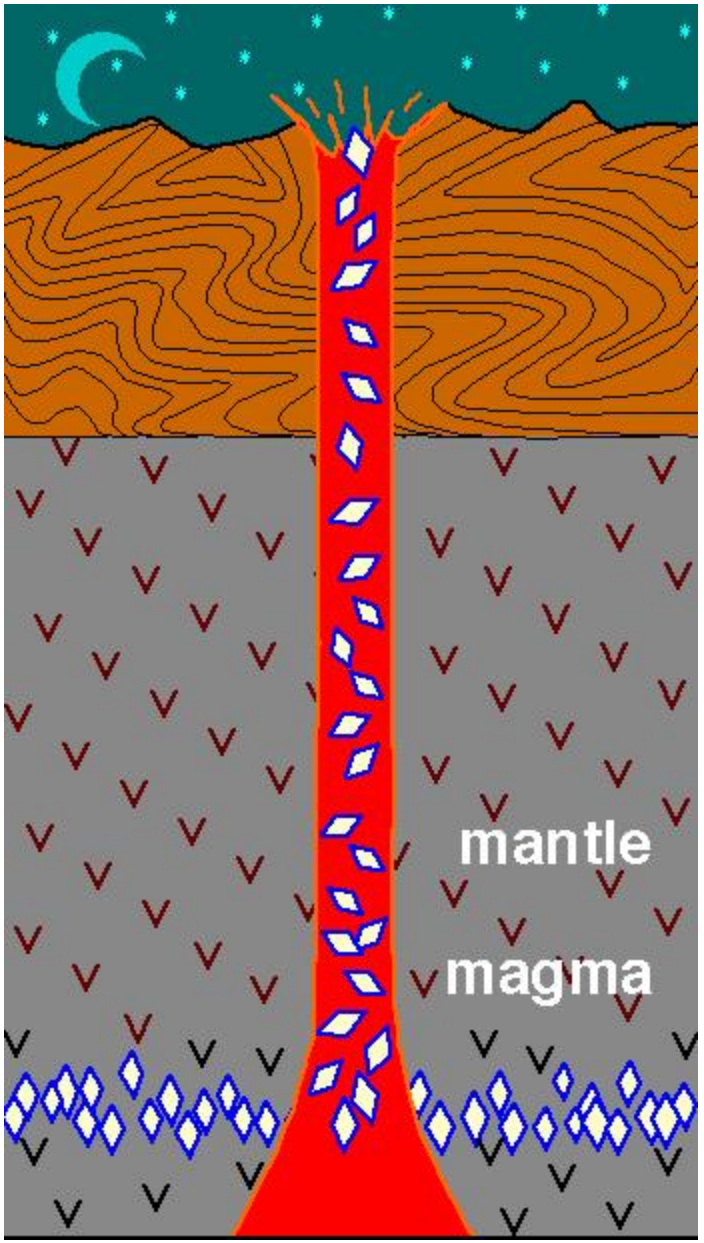
- This pic illustrates the process of contact metamorphism.
- This is the process by which the minerals in rocks change in response to proximity to a hot intrusive body.
- For example, a limestone intruded by a magma undergoes significant change in crystal size, mineral content, and chemistry (due to addition of solutions released from the cooling magma).
- These rocks contain gems such as garnet.



6. Gems formed in the mantle

- The most abundant upper mantle mineral is olivine (peridot). Slabs of mantle material are brought to the surface through tectonic activity and volcanism.
- **Deep mantle gems.** Rocks such as kimberlites are erruptive volcanics that come from quite deep in the mantle and carry with them diamonds. Diamonds are made from carbon. The stable form of carbon at the Earth's surface is graphite. High pressures and temperatures are required to convert graphite to diamond. Thus, almost all diamonds formed about 100 miles below the Earth's surface. Dates suggest that their formation was restricted to in the first few billion years of Earth history.
- Rarely, diamonds are formed in very high temperature and pressure metamorphic rocks.

- This pic shows that diamonds do not form in the kimberlite magma but are carried up to the surface by the magma.



Summary

- Gems are not always found where they were formed, nor are they formed where they're found!