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Notes on Gemstone Treatments and Enhancements

Treatment of gems to modify colors an old practice. Pick up Pliny's Natural History (1st Century AD) and read about use of dyes to make quartz look like emerald, redden stones, use of foil backings, heat, and applying thin coats of paint to alter gems appearance.

Many of these ancient practices, particularly the applications of oils and dyes, survive to the modern day. In Pliny's day use of these techniques constituted fraud, but today some are accepted as commonplace (oiling of emeralds, heating of aquamarine).

With the passage of the ages and the development of new technologies people tinkering with alteration of color in gemstones have developed an impressive list of techniques. In the last 40 years, with the incredible growth in technologies, the amount of experimentation has exploded so that today the treatment of gems is much more prevalent than in the past. This has occurred so rapidly that the ethical issues surrounding many treatment techniques are still hotly debated with the gem and jewelry industry.

Brief outline of prevalent treatment techniques given below.

Enhancement and Alteration of Color in Gemstones

I. Introduction
- A. Enhancement vs. Alteration; semantic differences.
  - Any man-induced change of color or clarity.
- B. Color -electrons are absorbers of light. We see what's left over.
  - Color of light being absorbed depends on the configuration of the electron present.
  - 1) Electrons that produce color are found in two different configurations:
    - a. First row transition metals present as impurities
    - b. Color Centers

II. Enhancement Techniques
- A. Dying - Oiling
  - Oldest of all practices. Pliny describes dyes applications to imitate ruby (wine, emerald (salts of copper used, with the urine of an "uncorrupted youth").

- B. Coatings
  - Foil backing, color tint applied. Common technique before advent of pavilion faceting to improve brilliance. Not so common today, except in inexpensive imitations.

C. Heat Treatment

1) Ancient Practices
   Carnelian (Brown or yellow to Red)
   Aquamarine (remove greenish hue)
   Amethyst to Citrine
   Blue to colorless sapphire
   Zircon (hyacinth)
   Brown topaz to pink

2) Modern Practices
   Ruby
   Colorless Orange, Yellow, Darker blue sapphire
   Tanzanite

3) Temperature Range - 300 -2000 ^{o} C
4) Practice - bury in substance (sand, lime, iron filings, Alumina powder, charcoal) so heat penetrates slowly, cool slowly.
5) Effects:
   a) Change valence of coloring element (change color, lighten, darken)
      Brownish Red Ruby => Red Ruby
      Amethyst => Citrine
      Brown Zoisite => Tanzanite
      Pale Yellow Sapphire => Golden Sapphire

   b) Destroy color centers (fading, change of color)
      Smokey Quartz => Colorless
      Brown Topaz => Pink Topaz

   c) Melt mineral inclusions (clarity, darken)
      Silky (Whitish) Blue Sapphire => Blue Sapphire

   d) Change hydration state (limonite to hematite)
      Brown Chalcedony => Carnelian
      Tigers Eye => Hawks Eye

   e) Precipitate new mineral (asterism)
      Sapphire => Star Sapphire

   f) Impurity Diffusion (add color)
      Colorless Sapphire + Fe and Ti paste => Blue Sapphire

D) Irradiation

Began with Curries who noted the glass tubes in which they stored their radium turned bluish. Present day desert-amethyst glass. Fraciose Bordas, buried sapphire in radium salt and noted change from colorless to yellow and blue to green. By 1909 use of Ra to turn colorless diamonds green had been noted.

1957- irradiation and heating to form blue topaz noted. By 1974 was being practiced in earnest. Serendipitous discovery. Topaz mixed in with a lot of quartz by mistake. Were studying smokey quartz -colorless quartz transition.

Pink Sapphire => Padparascha
Colorless Diamond => Fancy Diamond
Rock Crystal => Smokey Quartz
Citrine => Amethyst
Kunzite => Hiddenite
Colorless Topaz => yellow, orange, brown, or blue Topaz
Goshenite => Golden Beryl

All occur naturally in these colors. Natural radiation by decay of trace amounts of U, Th, and K, and bombardment by cosmic rays. Cummulative processs over long time periods. Pegmatites or K-rich rocks are particularly abundant sources of radiation.

Why isn't all quartz smokey, etc.? May have been heated. May have formed in non-radioactive environment.