

Historical background: mining, emerald treatments, and treatment determination

Emerald mining has taken place over more than the last two millennia. Among the oldest known mines are those in Egypt (Jennings et al., 1993) and Haubachtal, Austria; the mines in Austria, India, and the Ural Mountains of Russia were important throughout the 19th and 20th centuries, and many other deposits are now known. Since the mid-16th century, the most highly regarded emeralds came from the mines of Colombia, such as Muzo, Cosquez, and Chivor (see, e.g., Tenhagen, 1972; Keller, 1981). Emeralds were rumored to come from Brazil in the 1500s, and (re)discovered in Brazil in 1963, where at least two deposits (Nova Era or Capoeirana, and Santa Terezinha) have had significant production (see, e.g., Epstein 1989; Koivula and Kammerling 1989, 1991). Sandawana, Zimbabwe (see, e.g., Zwaan et al., 1997) is another important commercial source discovered in mid-century. Afghanistan, Pakistan, Zambia, Canada, and the United States (North Carolina) have all produced gem-quality emeralds in recent years (see, e.g., Shigley et al., 2000).

The earliest intentional fillers were probably natural oils, such as olive oil (Eliezri 1998). Cedarwood oil and Canada balsam, often used by the trade as emerald fillers, have commonly been used in microscopy since the late 1800s to examine mineral grains or to glue thin rock sections onto slides. Crowningshield first mentioned paraffin as a filler (albeit of a granular dumortierite-quartz rock) in 1964. At the end of the decade, he noted “epoxy or other fluorescent cement” being used to repair a broken emerald (Crowningshield, 1969-1970), and commented on the use of “new adhesives” soon thereafter (Crowningshield, 1971). The epoxy resin Opticon was introduced in print as a gemstone filler in 1986 (Jones, 1986), although it had been manufactured for many years before then. By 1989, surface-hardened Opticon was the preferred emerald filler in Santa Terezinha, Brazil (Koivula and Kammerling, 1989). The use of ultraviolet-setting adhesives in emeralds was noted by Koivula in 1987.

According to anecdotes, in the late 1980s, Merck changed the formulation of the cedarwood oil used for filling emeralds in Colombia. As a result, emerald treaters began to use the less expensive “palma” or “palm oil,” an unhardened Araldite resin (Johnson et al., 1999). In 1990, Kane commented on seeing a “flash effect” in an emerald (this effect is due to the close refractive-index match between emeralds and Araldite-like resins). In 1991, the Central Gem Laboratory (CGL) in Tokyo noted unhardened palma as well as other materials including an unidentified solid epoxy with lower refractive index and cyano-acrylate (“Super-Glue”) in filled emeralds. The widespread use of palma caused problems, in that about 20% of emeralds so treated developed clouds or milky-looking residues in surface-reaching fissures (Lurie, 1998). These artificial resins were also more difficult to remove from emeralds than cedarwood oil or Canada balsam (see, e.g., Hänni et al., 1999).

Opticon and similar resins act as cement (solid adhesives) when they have been hardened, but may be used as viscous liquids as well. In June 1997, Arthur Groom-Gematrat of New York and Bogotá announced a new filling process that included thorough emerald cleaning followed by filling with a proprietary solid resin, known as Gematrat (Johnson and Koivula, 1997). The following year, a lifetime guarantee was announced for the resin (Federman, 1998). Also in 1998, C.I. Gemtech Ltd. of Bogotá announced their own proprietary solid filler, called Permasafe (sometimes written as

PermaSafe; Weldon, 1999). In 2002, Gematrat was replaced with another proprietary filler, ExCel, and in 2003 a second version of ExCel with a lower refractive index—Excel 1.52—was introduced (Gomelsky, 2003).

Techniques used for filling emeralds have ranged from placing them in jars of oil on warm windowsills (Crowningshield, 1963) to using a vacuum to empty fissures before placing them in warm oil (Ringsrud, 1983; Kennedy, 1998), and using pressure to force the filler into emerald fissures (Ringsrud, 1983). Usually filling is preceded by one or more cleaning steps of various harshness (Ringsrud, 1983). In the mid 1990s, portable filling kits became available (see, e.g., Koivula et al., 1993), enabling dealers to conveniently fill small lots of emeralds. Of course, commercial facilities use larger equipment.

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