NOTES
· AND ·
NEW TECHNIQUES

A GEMOLOGICAL STUDY OF TURQUOISE IN CHINA

By Wang Fuquan

Gem-quality turquoise is currently being mined in Hubei Province, China. The material ranges in color from light blue to bluish green; it usually occurs as nodules 1 to 5 cm in diameter, although much larger pieces have been found. For the most part, the gemological properties of this Chinese turquoise are similar to those of material from other localities; one specimen was found to approach end-member turquoise in chemical composition.

According to ancient literature, turquoise has been known in China for more than 3,000 years. In 1977, more than 1,000 turquoise relics in the forms of cicadas, frogs, and other animals were unearthed from ruins dating to the Yin Dynasty (about 1300 B.C.) in Anyang, Henan. More recently, a turquoise necklace dating from about 100–7 B.C. was unearthed at Lijiashan, Jiangcheng County,Yunnan Province. Today, significant quantities of gem-quality turquoise are being mined at Yunxian and Zhushan in Hubei Province (Wang Fuquan, 1979). This article reports on the gemological characteristics of turquoise currently being mined in Hubei.

PHYSICAL AND OPTICAL PROPERTIES

Chinese gem-quality turquoises are light sky blue, greenish blue, and bluish green in color (see figures 1 and 2). Mössbauer and optical absorption spectroscopy of a greenish blue sample revealed that it contains iron (Fe^{3+}), which apparently plays an important role in affecting the color variability of turquoise from blue to greenish blue. Mineralogist Zhang Huifen (1982) showed that the light sky blue color (see photo in Keller and Wang, 1986) depends mainly on the presence of copper (Cu^{2+}) and that, with increasing amounts of iron, the color shifts from sky blue to bluish green and then to green. In addition, absorbed water darkens the color (Webster, 1983, p. 242).

Chinese gem turquoise is normally opaque but is translucent in thin section; it has spot refractive indices of 1.62–1.64, a waxy luster, a Mohs hardness of 4.6–5.5, a specific gravity of 2.696–2.698, weak greenish yellow fluorescence to both long- and short-wave ultraviolet radiation, and is tough and compact-massive, appearing as a scaly aggregate when observed in the SEM (figure 3). The optical absorption spectrum as seen with a hand spectroscope reveals a typical turquoise spectrum, with bands at about 432 and 460 nm. Color reflectivity measurements of the greenish blue sample described above indicate a dominant wavelength of 490 nm.

CHEMICAL COMPOSITION

The ideal chemical composition of gem turquoise is $CuAl_6(PO_4)_4(OH)_8 \cdot 4–5(H_2O)$. Chemical analy-

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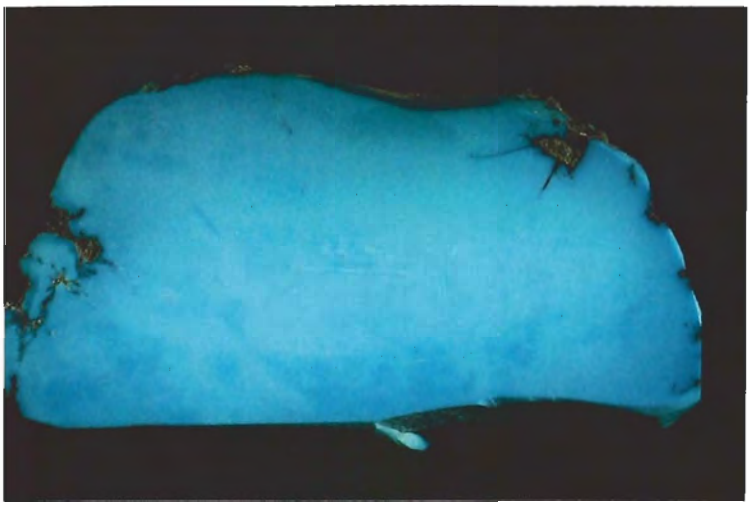

Figure 1. This 5.5-cm-long section of a turquoise nodule illustrates the almost solid blue color that can be seen in some of the finer specimens from Hubei Province.

sis of a sample of Chinese turquoise revealed that the specimen belongs to the turquoise-chalcosiderite isomorphous series and approaches end-member turquoise in composition, with trace amounts of zinc, calcium, fluorine, and ferric iron present. The CuO content of the sample analyzed is slightly lower than that of the theoretical value, but the Al_2O_3 and P_2O_5 contents approach the theoretical values for end-member turquoise more closely than do those of turquoise from any other famous locality (see, for example, Cid-Dresdner and Villarroel, 1972).

CHINESE TURQUOISE AS A GEM MATERIAL

Gem-quality Chinese turquoise is relatively pure and tough, with a fine and smooth appearance like jade, simple and elegant in color, and glittering like porcelain when polished.

In China, turquoise with a Mohs hardness above 5 is known as "porcelain turquoise," of which those specimens with a brilliant, unadulterated sky blue color are considered highest in quality. Less desirable is the turquoise with a hardness below 4.5 and those specimens that have been faded by weathering. Turquoise that is reticulated with fine-veined limonite (ferrian lines) is referred to by jewelers as "spiderweb turquoise"; specimens with clean, sharp lines are considered the finest quality.

The finest Chinese turquoise is comparable in quality to that from Iran, the Soviet Union, and the southwestern United States. It can be used in jew-

Figure 2. This snuff bottle (3.5 × 9.3 cm) has been carved from reticulated Chinese turquoise. Note the difference in color of the material used for the top as compared to that used for the body.

Figure 3. Chinese turquoise appears as a scaly aggregate when viewed with the scanning electron microscope.

Figure 4. This 3-kg vase (24 cm high), intricately carved with nine lions, is a particularly fine example of Chinese turquoise. Courtesy of the Geological Museum, Beijing.

elry that will sell at moderate or even high prices, and is one of the traditional materials used for handicrafts such as beads, vases, incense burners, and figurines. Among the exhibits in the Geological Museum of China is a fine turquoise vase carved with nine lions and weighing 3 kg (figure 4) that is an exceptional example of such carving.

GEOLOGY AND OCCURRENCE

In China, gem-quality turquoise is generally found in silicified limestones, primarily in tension fracture zones or in the axial part of folds. The turquoise is usually nodular in appearance (again, see figure 1) with various structures that include oolitic, pisolitic, botryoidal, or brecciated. As a rule, the nodules range from 1 to 5 cm in diameter. Vein deposits may be single or multiple in the fracture zones; they are usually less than 1 cm in width and more than 1 m in length. Common associated minerals include quartz, halloysite, allophane, limonite, sericite, variscite, pyrite, and jarosite. The boundaries of the deposits are well defined, with no trace of hydrothermal alteration having been observed, which indicates that the ores represent leaching deposits produced by weathering.

SUMMARY AND CONCLUSIONS

Significant quantities of gem-quality turquoise are currently being mined in Hubei Province, China. This material ranges in color from light blue to bluish green. The finest specimens are evenly colored "sky blue" nodules, and rival the finest turquoise from other, more famous localities. Chinese turquoise is currently used in jewelry and carvings, including beads and statuettes.

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