GEM STONE RESOURCES OF SOUTH CAROLINA

By

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To The Honorable Donald S. Russell
Governor of South Carolina

Sir:

Submitted herewith is State Development Board Bulletin 30, Gem Stone Resources of South Carolina. This report by Camilla K. McCauley was prepared as part of the Division of Geology's continuing program of investigation of the geology and mineral resources of the State.

Sincerely,

Walter W. Harper, Director
Henry S. Johnson, Jr., State Geologist

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GEM STONE RESOURCES OF SOUTH CAROLINA

By

Camilla K. McCauley

ABSTRACT

Gem stones are minerals and certain other natural substances that are used for decorative purposes in jewelry, and, to a lesser extent, in art objects. They are valued for their beauty, durability, rarity, portability, and cut or "make." More than 135 different substances have been used for gems or for ornamental purposes. In addition, gem stones are also important in a number of industrial applications.

The total value of all gem stones produced in the United States since 1880, when the first gem-mining company began operations, is about $21 million, or slightly less than 0.5 percent of the total world production for the same period. Most of the domestic production comes from thousands of amateur collectors and a few professional operators. The principal materials mined are agate, jade, petrified wood, quartz, and turquois. In 1959 the total value of all gem stones produced in the United States amounted to $1,185,000, and the material came principally from Oregon, California, Utah, Nevada, Texas, Arizona, Wyoming, Washington, Colorado, New Mexico, and Montana.

Gem stones reported from South Carolina, from the northwestern part of the State, include beryl (aquamarine, emerald, yellow beryl), corundum (sapphire), diamond, garnet, quartz (amethyst, chalcedony, smoky, colorless), petrified wood, sillimanite, topaz, tourmaline, and zircon. In 1959, production of gem stones in South Carolina was limited to small amounts of sillimanite from Oconee County, tourmaline from Spartanburg County, and miscellaneous gem stones from Lexington County. No production was recorded in 1960.

INTRODUCTION

Gem stones are naturally occurring mineral substances that are used for personal adornment, ornamental objects, and various industrial purposes. They have been described formerly as either precious or semi-precious according to value. All gem stones today are generally referred to as precious.

The attributes which determine the value of a gem stone are (1) the beauty or splendor, which depends on color, transparency, indices of refraction, dispersion, and visible perfection; (2) the durability or resistance of a gem stone to abrasion, chipping, pitting, and splitting; (3) rarity; (4) portability; and (5) the "make" of a gem, which is a measure of the perfection of its cut and finish from the original rough form (Jahns, 1960, p. 383-384).

More than 135 different substances possess the attributes noted above. These substances are dominantly minerals, and hence can be relegated to the usual classification of minerals based on chemical composition. Accordingly, gem minerals are found within the following groups, in descending order of abundance: silicates, aluminosilicates, oxides, sulfides, phosphates, borosilicates, carbonates, native elements, sulfates, titanosilicates, borates, halides, and aluminates (Jahns, 1960, p. 384).

Four substances of organic origin are also considered to be gem stones. These are amber, coral, jet, and pearl. Also used for gem purposes, but not included here, are obsidian and other natural glasses. The more important gem stones and their characteristics are listed in Table 1.

HISTORY AND PRODUCTION

Gem materials have been used for decorative purposes, as media of exchange, as a method of investment, and for utilitarian purposes for thousands of years. The most important gem-producing areas since historic times are: the Baltic region for amber (prior to 7000 B. C. — 3400 B. C.); Egypt for turquois and emerald (3400 B. C. — 200 B. C.); India and Ceylon for diamond, ruby, and sapphire (200 B.C. -- 1725); Brazil for diamonds (1725-1870); and Africa for diamonds since 1870 (Ball, 1937, p. 303; Jahns, 1960, p. 418).

Present world production of gem stones comes principally from Africa, South America (Brazil, British Guiana, and Venezuela), Australia, Burma, Ceylon, Madagascar, and Mexico.

The value of the annual world production of gem stones has risen steadily since 1943 and reached or exceeded $200 million in recent years due primarily to the increasing demand for diamonds, which in 1955 accounted for 96 percent of the total value of all gem materials produced during the year. In 1960, gem diamonds accounted for 86 percent of the total value of all gem materials imported during the year. The Belgian Congo has produced from 60 to 73 percent of the total world production of diamonds in recent years, and most of this has been industrial diamond. The largest producers of gem quality diamonds are South Africa, Angola, Tanganyika, and Brazil.

The first gem-mining company in the United States was the Emerald and Hiddenite Mining Company which operated in North Carolina between 1880-1888. Prior discoveries, such as tourmaline in Maine (1820) and sapphire in Montana (1865), were operated in only a desultory manner. In the 1890's rather extensive mining operations were begun at a number of old Indian workings for turquois, quartz, petrified wood and other minerals in the Southwest.

Until about 1935, gem stone mining operations were usually carried on by professional operators and mining companies. The principal gem stones mined were ruby, sapphire, tourmaline and turquois; and these were marketed mainly through established trade channels. In recent years most of the domestic production has come from thousands of amateur collectors and some professional collectors and individual operators. A few small companies are also in operation and in

TABLE 1—*Properties of Gem Minerals and Other Gem Materials* 1/

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
Actinolite	Ca, Mg, Fe, OH silicate	Green, yellowish green		x	5–6	3.0–3.2	Mod.	Compact bundles and mats of prisms or fibers
[Allanite (Orthite)]	Ca, Na, Al, Fe, Mn, Mg, rare-earths, OH aluminosilicate	Brown, brownish green, black		x	6	3.5–4.2	High	Bright, pitchy luster
AMBER	Hydrocarbon	Yellow; grayish, reddish, brownish, greenish	x	x	2–2½	1.0–1.1	Low	Commonly contains small inclusions of other organic matter
[Amblygonite]	Li, Na, Al, F, OH phosphate	White, pinkish, reddish, greenish, bluish, yellowish, brownish	x	x	5½–6	3.0–3.2	Mod.	Color generally very pale
[Anatase]	Ti oxide	Yellow, blue, brown, black	x		5½–6	3.8–4.0	Extreme	Adamantine luster; color zoning in some crystals
Andalusite	Al silicate	Gray, pink, green, yellowish, brown, red, violet	x		6–7	3.1–3.2	Mod.	Regularly disposed carbonaceous inclusions in chiastolite
Chiastolite				x				
Apatite	Ca, F, Cl, OH phosphate	Colorless, yellow, green, blue, pink, violet	x		4½–5	3.0–3.2	Mod.	Uneven color and color zoning common
[Axinite]	Ca, Mn, Fe, Mg, Al, OH borosilicate	Gray, blue, yellow, yellowish-reddish brown, green, violet	x		6½–7	3.3	Mod.	Distinct pleochroism common
Azurite	Cu, OH carbonate	Deep blue		x	3½–4	3.8	High	Commonly with malachite
Benitoite	Ba, Ti silicate	Colorless, blue, purple	x	x	6–6½	3.6	High	Uneven color in many crystals
BERYL								
Aquamarine	Be, Al silicate	Blue, greenish blue	x	x	7½–8	2.6–2.9	Mod.	Mild dispersion; pleochroism recognizable in some varieties; some crystals yield cat's-eye stones
Emerald		Green	x					
Golden beryl, Heliodor		Yellow, orangy	x					
Goshenite		Colorless	x					
Morganite		Pink, peach, rose-red	x	x				
Common beryl		Green, yellowish green	x	x				
[Beryllonite]	Na, Be phosphate	Colorless to pale yellow	x		5½–6	2.85	Mod.	Some crystals yield cat's-eye stones
[Brazilianite]	Na, Al, OH phosphate	Yellow-green	x		5½	3.0	Mod.	
CALCITE								
Satin spar	Ca carbonate	White, pink, reddish, bluish, greenish, brownish, etc.		x	3	2.7	Low to Mod.	Satin spar chatoyant; marble mottled; Mexican onyx variegated in layers
Marble				x				
Mexican onyx				x				

1/ Jahns, Richard H., 1960, p. 385-392.

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
[Cassiterite]	Sn oxide	Colorless, yellow, red, brown, gray, black	x		6–7	6.5–7.1	V. high	Adamantine luster; color zoning in some crystals
[Celestite]	Sr sulfate	Blue, gray, yellowish	x		3½	4.0	Mod.	Pleochroism recognizable in deeply colored specimens
[Chromite]	Fe, Cr oxide	Brownish black to black		x	5½–6	4.6–5.2	V. high	Pitchy, submetallic to metallic luster
CHRYSOBERYL								
Alexandrite	Be aluminate	Green (daylight), red (artificial light)	x		8½	3.5–3.8	High	Strong pleochroism; mild dispersion
Cat's-eye (Cymophane)		Yellowish green to green		x				
Chrysolite		Yellowish, bluish, and brownish green	x					
Chrysocolla	Cu silicate, hydrous	Green, blue		x	2–2½	2.0–2.4	Low to Mod.	Commonly impregnated with silica
[Cinnabar]	Hg sulfide	Red, brownish to grayish red	x	x	2–2½	8.1	Extreme	Adamantine luster
[Cobaltite]	Co, As sulfide	Pinkish silvery white		x	5½	6.0–6.4	Extreme	
CORAL								
Black coral	Ca carbonate	Black		x	3½–4	2.6–2.7	Mod.	Branching forms common
Common coral		White, gray, green, etc.		x				
Precious coral		Orange-red to red		x				
Cordierite (Iolite, dichroite)	Al, Mg, Fe aluminosilicate	Gray, blue, yellowish, reddish, greenish, brown	x	x	7–7½	2.5–2.8	Low	Strong pleochroism common
CORUNDUM								
Ruby	Al oxide	Pink, red, orangy to purplish red, purple	x	x	9	3.9–4.1	High	Color zoning common; distinct pleochroism; mild dispersion
Sapphire		Colorless, blue, yellow, pink, green, violet, etc.	x	x				
Star ruby and star sapphire				x				
[Covellite]	Cu sulfide	Blue to blue-gray		x	1½–2	4.6–4.8	Extreme	Submetallic luster
[Danburite]	Ca borosilicate	Colorless, yellow, yellowish brown	x		7	3	Mod.	Very strong dispersion
Datolite	Ca, OH borosilicate	White, gray, yellowish, reddish, greenish, brownish		x	5–5½	2.9–3.0	Mod.	Streaking or uneven color distribution common

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
DIAMOND	C	Colorless, blue-white, yellow, red, brown, green, blue, gray	x		10	3.5	Extreme	Adamantine luster; very strong dispersion
Diopside	Ca, Mg, Fe silicate	Colorless, gray, yellow, green, blue	x		5–6	3.2–3.4	Mod.	Color zoning in many crystals
Dioptase	Cu silicate, hydrous	Green	x		5	3.3	Mod.	Resembles emerald
[Dumortierite]	Al, B, OH aluminosilicate	Blue, greenish blue, reddish violet		x	7	3.3	Mod.	Very strong pleochroism; commonly in dense aggregates with quartz
Enstatite Bronzite	Mg silicate	White, gray, yellowish, brownish, greenish		x	5–6	3.2	Mod.	Bronzite variety fibrous, with chatoyance and bronzy luster
Epidote (Pistacite)	Ca, Al, Fe, OH aluminosilicate	Gray, yellow, yellow-green, green, reddish, brown	x	x	6–7	3.3–3.5	High	Strong pleochroism; mild dispersion
[Euclase]	Be, OH aluminosilicate	Colorless, green, blue	x		7½	3.0–3.1	Mod.	Colors generally pale; mild pleochroism
[Euxenite]	Ca, rare-earths, U, Th, Cb, Ta, Ti oxide	Brown to black		x	5–6	4.8–5.9	V. high to Extreme	Bright, pitchy luster
FELDSPARS								
Adularia, Orthoclase	K, Na aluminosilicate	Colorless to yellow	x		6–6½	2.5–2.8	Low to Mod.	Moonstones opalescent, chatoyant; sunstone red spangled; aventurine green or red spangled; nontransparent gem labradorite and oligoclase gray with marked play of colors
Amazonstone		Green, bluish to yellowish green		x				
Precious moonstone		White to bluish gray		x				
Aventurine	Na, K, Ca aluminosilicate	White or gray		x				
Moonstone				x				
Sunstone				x				
Labradorite, Oligoclase	Ca, Na aluminosilicate	White, gray	x	x				
[Fergusonite]	Rare-earths, Fe, Cb, Ta, Ti oxide	Gray, yellow, brown, black		x	6	4.0–7.0	V. high	Bright, pitchy luster in darkest varieties
Fluorite	Ca fluoride	Colorless, white, yellow, green, blue, red, purple, brown	x	x	4	3.1–3.3	Low	Uneven color and color zoning common
[Gadolinite]	Fe, Be, rare-earths silicate	Brown, greenish brown, black		x	6½–7	4.0–4.6	High	Bright to moderately dull luster
GARNETS								
Almandite (Carbuncle)	Fe, Al silicate	Red, violet, brownish, black	x	x	7½		High	Color zoning common in some varieties; dispersion moderate to high; some varieties show asterism
Pyrope	Mg, Al silicate	Red to black	x		7–7½			
Rhodolite	Mg, Fe, Al silicate	Rose-red to purple	x		7–7½	3.4–4.3		

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
GARNETS (Contd)								
Grossularite	Ca, Al, Fe silicate	White, yellow, red, green, brown	x	x	7	3.4–4.3	High	Color zoning common in some varieties; dispersion moderate to high; some varieties show asterism
Spessartite	Mn, Fe, Al silicate	Red, orangy, yellowish, brown	x		7–7½			
Essonite (Hessonite)	Ca, Mn, Fe, Al silicate	Yellowish orange to orange-brown	x		7–7½			
Demantoid		Yellow to green	x					
Melanite	Ca, Fe, Al silicate	Black		x	6½–7			
Topazolite		Yellow	x					
Uvarovite	Ca, Cr silicate	Green	x		6½–7			
GLASSES (manufactured)	Wide range of silicates, borosilicates, etc.	Colorless, any color	x	x	2½–5	1.3–5.5	Low to Extreme	Wide range in luster, dispersion, etc.
Gold	Au	Golden yellow		x	2½–3	16–19		Commonly in quartz
GYPSUM								
Alabaster	Ca sulfate, hydrous	White		x	2	2.2–2.4	Low	Satin spar fibrous, silky, chatoyant
Satin spar			x	x				
[Hambergite]	Be, OH borate	Colorless	x		7½	2.4	Mod.	
[Haüynite]	Na, Ca sulfate-aluminosilicate	Blue, green, red, yellow		x	5½–6	2.4–2.5	Low	Uneven color common
[Helvite]	Mn, Fe, Zn, Be, S silicate	Gray, yellow, red, green, brown	x		6	3.2–3.7	High	
HEMATITE	Fe oxide	Steel gray to black		x	5–6½	4.9–5.3	Extreme	Bright metallic luster
[Hemimorphite (Calamine)]	Zn, OH silicate, hydrous	Colorless, white, blue, green, gray, brown	x	x	5	3.4–3.5	Mod.	Strong dispersion
[Howlite]	Ca, OH borosilicate, hydrous	White		x	3½	2.6	Mod.	Commonly in matrix of other minerals
Hypersthene Bronzite	Mg, Fe silicate	Yellow, brown, green		x	5–6	3.3–3.5	Mod. to High	Bronzite variety fibrous to lamellar, with chatoyance and bronzy luster
Idocrase (Vesuvianite)	Ca, Mg, Fe, Al, OH silicate	Green, brown, yellow, blue		x	6½	3.3–3.5	High	Color uneven in some specimens
JADE								
Jadeite	Na, Al silicate	White, green, yellowish, brownish, violet		x	6½–7	3.3	Mod.	Compact and tough; color commonly uneven, with mottling in white
Nephrite	Ca, Mg, Fe, OH silicate	Yellowish green		x	6½–7	3.0–3.2	Mod.	
JET	C, with H, O, etc.	Black		x	2–2½	1.1–1.4		Tough and compact; resinous luster

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
Kornerupine	Mg, Fe, Al borosilicate	Colorless, yellow, green, brown	x		6½	3.3–3.5	Mod. to High	
Kyanite	Al silicate	Colorless, gray, blue, green, brown	x	x	4–7	3.5–3.7	High	Uneven color common; strong pleochroism
Lazulite	Mg, Fe, Al, OH phosphate	Blue		x	5–6	3.1–3.4	Mod.	Distinct pleochroism
LAZURITE (Lapis lazuli)	Na, S aluminosilicate	Deep blue to greenish blue		x	5–5½	2.4–2.9	Low	Commonly with matrix of pyrite and other minerals
[Lepidolite]	K, Li, Al, F, OH aluminosilicate	Colorless, gray, pink, red, violet, purple, yellow		x	2½–4	2.8–3.3	Low to Mod.	Mainly in dense crystalline aggregates
Malachite	Cu, OH carbonate	Green		x	3½–5½	3.9–4.0	Mod. to High	Commonly impregnated or interlayered with other minerals
[Marcasite]	Fe sulfide	Bronze yellow		x	6–6½	4.9		
[Microlite]	Ca, Na, F, OH, Ta, Cb oxide	Yellow, red, green, brown, black	x		5–5½	5.5–6.4	V. High	Color zoning common
Moldavite (Tektite)	Aluminosilicate glass	Green, yellowish green, brown, light to very dark gray	x	x	5½	2.3–2.5	Low	Possibly of meteoritic origin
[Nepheline]	Na, K aluminosilicate	Colorless, gray, yellowish, pinkish, reddish		x	5½–6	2.6	Low	Commonly with haüynite, sodalite
Obsidian	Aluminosilicate glass	Colorless, red, green, brown, black	x	x	5–5½	2.3–2.6	Low to Mod.	Some types variegated
OLIVINE								
Chrysolite	Mg, Fe silicate	Yellow, greenish yellow, brownish	x	x	6½–7	3.2–3.5	Mod. to High	Mild dispersion
Peridot		Slightly yellowish green	x					
OPAL	Si silicate, hydrous	Colorless, many colors		x	5½–6½	1.9–2.3	Low	Play of colors; many varieties impure
PEARL	Ca carbonate	White, gray, black, many pale colors		x	2½–4	2.5–2.7	Mod.	Various natural shapes used
[Pectolite]	Na, Ca, Mn, OH silicate	Colorless, white, gray, pinkish		x	4½–5	2.7–2.9	Mod.	Commonly fibrous
Phenakite	Be silicate	Colorless, yellow, rose-red, brown	x		7½–8	3.0	Mod.	
[Pollucite]	Cs aluminosilicate	Colorless, white, gray, pinkish	x	x	6½	2.9	Low	

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
[Polycrase]	Ca, rare-earths, U, Th, Ti, Cb, Ta oxide	Brown to black		x	5–6	4.8–5.4	Extreme	Bright, pitchy luster
Prehnite Chlorastrolite	Ca, Al, OH alu-minosilicate	White, gray, yellow-ish green, green		x	6–6½	2.8–3.2	Mod.	Chlorastrolite green with white mottling; chatoyant
PYRITE	Fe sulfide	Brass yellow		x	6–6½	5.0		Some crystals used in natural form
[Pyrochlore]	Na, Ca, rare-earths, Th, U, Mg, Fe, Mn, Cb, Ta, F oxide	Reddish brown to black		x	5–5½	4.2–5.7	V. high to Extreme	Bright, pitchy luster
QUARTZ								
Megascopically crystalline varieties:								
Amethyst	Si silicate	Purple, violet	x	x	7	2.7	Low	Aventurine spangled, glis-tening; cat's-eye and tiger-eye fibrous, chatoyant; gold quartz with native gold; rutilated quartz with many needles of rutile Color commonly uneven; some varieties show asterism
Aventurine		Yellow, red, green, brown		x				
Cat's-eye		Gray, green, brown		x				
Citrine		Yellow	x					
Gold quartz		Milky white		x				
Rock crystal		Colorless	x					
Rose quartz		Rose-pink	x	x				
Rutilated quartz (Sagenite)		Colorless to smoky yel-low	x	x				
Sapphire quartz (Siderite)		Blue	x					
Smoky quartz (Cairngorm)		Smoky yellow to black	x	x				
Tiger-eye		Red, blue, brown		x				
Cryptocrystal-line varie-ties:								
Agate	Si silicate, com-monly somewhat impure	Varicolored		x	7	2.6	Low	Agate with curved or angular bands; onyx and sardonyx with straight bands; blood-stone with red spots and veins; jasper with bands or irregular markings; plasma with white or yellowish spots; many combinations are known
Bloodstone		Dark green		x				
Carnelian		Red, orange-red		x				
Chalcedony		White, gray, bluish, black		x				
Chrysoprase		Light green		x				
Jasper		Yellow, red, brown, green, bluish gray		x				
Onyx		Varicolored		x				
Plasma		Green		x				
Prase		Green		x				
Sardonyx		Red, brown, white		x				
[Realgar]	As sulfide	Red to orange-yellow		x	1½–2	3.6	Extreme	Commonly with matrix of other minerals

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
[Rhodizite]	Na, K, Li, Al, Be borate	Colorless, yellow	x		8	3.4	Mod.	
Rhodonite	Mn, Fe, Ca silicate	Pink, rose-red, gray, yellowish		x	5½–6½	3.4–3.7	High	Commonly with black spots and veins
Rutile	Ti oxide	Yellow, red, violet, brown, greenish, bluish, black	x	x	6–6½	4.2–4.3	Extreme	Adamantine luster
[Samarskite]	Ca, Fe, rare-earths, Pb, Th, Cb, Ta, Ti, Sn oxide	Brown to black		x	5–6	5.6–6.2	Extreme	Bright, pitchy luster
Scapolite (Wernerite)	Na, Ca, Cl, CO_3, SO_4 aluminosilicate	Colorless, white, gray, pink, reddish, bluish, greenish	x	x	5–6	2.5–2.8	Low to Mod.	Chatoyance in some varieties
[Scheelite]	Ca tungstate	Colorless, white, gray, yellow	x		4½–5	6.1	V. high	
Sepiolite (Meerschaum)	Mg, OH aluminosilicate, hydrous	White, creamy yellow, pink, greenish		x	2–2½	1–2	Low	
Serpentine	Mg, OH silicate	Yellow, light to very dark green		x	2–4	2.5–2.8	Mod.	Fibrous to massive; color mottling and streaking in some varieties
Sillimanite	Al silicate	White, gray, greenish, brownish		x	6–7½	3.2	Mod.	Commonly in tough, fibrous aggregates
Smithsonite	Zn carbonate	White, yellow, green, blue		x	5	4.1–4.5	Mod. to High	
Sodalite	Na, Cl aluminosilicate	Colorless, gray, yellow, pink, blue, green		x	5–6	2.2–2.4	Low	Commonly with nepheline, haüynite
Sphalerite	Zn sulfide	Colorless, yellow, red, green, brown, black	x		3½–4	3.9–4.1	Extreme	Resinous adamantine luster; extreme dispersion
Sphene (Titanite)	Ca titanosilicate	Gray, yellow, green, brown, red, black	x		5–5½	3.4–3.6	High to V. high	Distinct pleochroism; strong dispersion; color zoning common
SPINELS	Mg, Fe, Zn, Al oxide	Yellow, pink, red, orange-red, violet, purple, blue, green	x	x	8	3.5–3.7	High	Moderate dispersion; asterism in some varieties
SPODUMENE								
Hiddenite	Li, Al silicate	Yellow-green to green	x		6–7	3.0–3.2	Mod.	Distinct pleochroism; mild dispersion
Kunzite		Pink to lilac	x					
Triphane		Yellow to colorless	x					
Staurolite	Al, Fe, OH silicate	Reddish to yellowish brown, brownish black	x	x	7–7½	3.6–3.8	High	Cruciform twins common; moderate dispersion

TABLE 1—*Properties of Gem Minerals and Other Gem Materials (Continued)*

Mineral or other substance*	General composition	Chief color or colors	Transparent†	Nontransparent†	Mohs hardness	Specific gravity	Index or indices of refract.‡	Other features
Steatite (Soapstone) Agalmatolite	Mg, OH silicate	White, gray, green, reddish, brownish		x	1½–2½	2.7–2.8	Low to Mod.	Compact aggregate of talc and other minerals
Thomsonite	Na, Ca aluminosilicate, hydrous	Colorless, white, yellow, pink, red, green		x	5–5½	2.3–2.4	Low	Color mottling and banding common
TOPAZ	Al, F, OH silicate	Colorless, pink, yellow, blue, purplish, reddish, orangy, brownish	x		8	3.4–3.6	Mod.	Mild dispersion
TOURMALINE	Na, Li, Fe, Al, OH borosilicate				7–7½	2.9–3.2	Mod.	Color zoning very common; some varieties yield cat's-eye stones; strong pleochroism; mild dispersion
Achroite		Colorless	x					
Emeralite		Green	x	x				
Indicolite		Blue	x					
Rubellite		Rose-red to purplish	x	x				
Schorlite		Black	x	x				
Siberite		Violet	x					
Other varieties		Green, yellow, brown, etc.	x	x				
TURQUOIS	Cu, Al, OH phosphate, hydrous	Green, blue, yellowish, greenish gray		x	5–6	2.6–2.8	Mod.	Commonly in matrix of other minerals
Variscite	Al, Fe phosphate, hydrous	White, yellow, blue, green		x	3½–5	2.5–2.8	Mod.	Commonly in matrix of other minerals
[Willemite]	Zn silicate	White, gray, yellow, red, green, blue, brown	x		5–6	3.9–4.2	Mod. to High	Deeply colored varieties pleochroic
ZIRCON	Zr silicate				6–7½	4.0–4.8	V. high	Strong dispersion; commonly metamict, wholly or in part
Blue zircon		Blue, greenish blue	x					
Hyacinth, Jacinth		Yellow, orange, red, brown	x					
Jargon		Gray, green, smoky brown, etc.	x					
White zircon		White	x					
Zincite	Zn oxide	Red, orange, yellow	x		4	5.4–5.7	V. high	
Zoisite	Ca, Al, OH aluminosilicate	Colorless, gray, green, brown		x	6–6½	3.2–3.4	Mod. to High	Colored varieties strongly pleochroic
Thulite		Pink, rose-red		x				

* Those substances in most common use are shown in capital letters; those rarely used for gems or for ornamental purposes are shown within brackets.

† As ordinarily used for gem or ornamental purposes.

‡ Designated as follows:

Low—<1.56
Mod.—1.56–1.70
High—1.70–1.90
V. high—1.90–2.10
Extreme—>2.10

1958 eight companies produced about 1 percent of the total domestic production. The principal materials now mined are agate, jade, petrified wood, quartz crystal, and turquois. Much of the domestic production is retained by collectors, and some is sold through local dealers and rock shops (Jahns, 1960, p. 423; Hartwell, 1960, p. 325). Some gem stones are exported. Jade, for example, is now sent to West Germany to be polished or carved into gems and ornaments.

According to Jahns (1960, p. 420-422) the total value of all gem stones produced in the United States since 1880 is about $21 million, or slightly less than 0.5 percent of the total world production for the same period. From two major annual production peaks of slightly over $500,000 set in 1909 and 1921, the value of all gem stones produced in the United States plunged to an all-time low of $3,200 in 1934 as a result of the depression. Annual production figures have risen since then, except during World War II, to a value of $1,185,000 in 1959. The states producing the most gem stone in 1959 were Oregon, California, Utah, Nevada, Texas, Arizona, Wyoming, Washington, Colorado, New Mexico, and Montana (Hartwell and Brett, 1960, p. 471).

OCCURRENCE

Gem stones may occur as minor constituents in almost every type of rock and mineral deposit. They are formed chiefly, however, by (1) igneous activity, both in magmatic crystallization and pegmatite formation; (2) metamorphic processes; (3) aqueous solutions and organic accumulations; and (4) mechanical concentrations (placer deposits) (Jahns, 1960, p. 401-402).

Igneous Rocks

Mafic and ultramafic igneous rocks have been found to yield diamond, sapphire, ruby, garnet, olivine, and a number of other gem materials. These are the most important primary sources of diamonds, which occur irregularly disseminated in dikes and plugs of kimberlite, peridotite, and allied ultramafic rocks. These plugs or funnel-shaped pipes appear to be the eroded remnants of volcanic necks and range from fifty feet to almost a mile in diameter across a roughly oval outcrop pattern. Some pipes are barren, while others yield a variable amount of gems, the abundance of which generally decreases with depth (Jahns, 1960, p. 402).

Pegmatites contain a greater variety and abundance of gem minerals, other than diamond, than other igneous rock types. Among the gem minerals occurring in pegmatites are emerald and other beryl varieties, chrysoberyl, feldspar, garnet, quartz, ruby and sapphire, spinel, spodumene, topaz, tourmaline, zircon and others.

In the Southeastern Piedmont, pegmatites have yielded some gem stones, chiefly beryl (aquamarine, emerald, golden beryl), corundum, feldspar (amazonstone, moonstone), garnet, quartz (amethyst, smoky, rutilated), spodumene (hiddenite, kunzite), and zircon. These occurrences are located principally in North Carolina and Virginia. Among other minerals found in these pegmatites in the Southeast and used as mineral specimens are cleavelandite, cassiterite, microlite, helvite, phenakite, and topaz. Mining has been intermittent, generally on a very modest scale, and mainly by individuals in recent years. Although some material has been cut into gems, much has been sold as mineral specimens (Jahns, Griffitts, and Heinrich, 1952, p. 76-80).

Only a small percentage of known pegmatites contain gem stones. Jahns (1960, p. 402-403) states that these are chiefly of "granitic and syenitic to quartz dioritic composition. Such bodies range in shape and size from thin stringers and nut-sized pods to thickly tabular and bulbous masses hundreds of feet long, but no correlation has been established between dimensional features and content of gem minerals. The crystals of best quality ordinarily are concentrated in well-defined 'pockets' or 'pay streaks' which are ellipsoidal to highly irregular in form and rarely constitute large parts of the containing pegmatite bodies.

"Some pockets are true cavities with crystal-studded walls, but most are partly or completely filled with compact to spongy aggregates of quartz, alkali feldspars, and various micas and clay minerals. Commonly scattered through these aggregates are superbly formed crystals of other minerals, many of them transparent and some of them flawless, as well as broken fragments or residual parts of such crystals. Some gem minerals also are disseminated or sporadically scattered through essentially solid pegmatite, but the yield of high-quality material from such 'frozen' crystals generally is low. Milky quartz and rose quartz are obtained from aggregates of very large anhedral crystals that occur chiefly in the central parts of pegmatite bodies without pockets...".

Other igneous rocks yield minor quantities of gem stones. Garnet, zircon, and sphene may occur as accessory constituents in certain granitic intrusives. In addition, feldspar, quartz, and topaz also occur in miarolitic cavities.

Jahns observes further (1960, p. 403-404) that "Felsic to mafic intrusive rocks of alkaline affinities yield sapphire and ruby, feldspars, feldspathoids, melanite and grossularite garnets, and zircon. Volcanic rocks of intermediate to basic composition are sources of sapphire, ruby, plagioclase feldspars, olivine, and pyrope garnet. Diamond occurs in the matrices of some intermediate to basic igneous breccias that appear to have formed as volcanic throat rocks."

Metamorphic Rocks

Among the gem minerals found in schists and gneisses are emerald, ruby, sapphire, beryl, chrysoberyl, garnet, jade, quartz, topaz, and others. Most of these deposits are associated with pegmatites or other igneous rocks.

Gem stones also occur in marbles and other calcareous metamorphic rocks as (1) groups of well-formed crystals lining primary cavities, (2) small individual crystals disseminated through the host rock, and (3) large, irregular crystals and crystalline masses. Among the gem minerals found in this type of deposit are spinel, lazurite, emerald, ruby, sapphire, garnet and tourmaline. "Some occurrences are in regionally metamorphosed terranes, but most are contact-metamorphic, are associated with intrusive rocks of basic to silicic composition, and range lithologically from nearly pure marble to skarn, tactite, and other silicated rocks." (Jahns, 1960, p. 404). The quality and amount of gem minerals found in these deposits vary considerably.

Aqueous Solutions and Organic Accumulations

Hydrothermal solutions and other aqueous fluids have formed deposits of a variety of gem minerals. These deposits occur as veins, cavity-fillings, fissure-fillings, stockworks, and disseminations in different types of host rocks. Among the gem minerals that may occur in such deposits are opal, quartz, calcite, emerald, feldspar, gypsum, garnet, hematite, pyrite, topaz, tourmaline, and others.

The principal gem materials formed by organic accumulations are jet, coral, amber, and pearl. Jet is a dense, compact variety of lignite found in sedimentary rocks. Amber is a fossil resin from prehistoric coniferous trees, found in sedimentary rocks.

Placer Deposits

Gem-bearing placer deposits are generally richer than the primary source occurrences because of the selective sorting of currents. Placers occur in ancient and modern stream gravels, beach gravels, desert gravels, playas, fluviatile and lacustrine terraces, uplifted bars and beaches, and glacial formations. Among the gem stones that have been commercially obtained from such deposits are agate, diamond, garnet, jade, quartz, ruby, sapphire, tourmaline, and zircon.

"Specific gravity and physical resistance are primarily responsible for the preservation and distribution of detrital gem materials... Gem stones of relatively high specific gravity typically are concentrated at or near the bottoms of gravel sections, mainly in pockets and elongate 'streaks' of sinuous form. Some of the richest concentrations are found in crevices, potholes, and other depressions in the immediately underlying bedrock. Many placer sections include layers and lenses of relatively fine-grained, impervious sediments that constitute 'false bottoms,' above which perched accumulations of gem materials are sometimes encountered" (Jahns, 1960, p. 406).

SOUTH CAROLINA GEM STONE DEPOSITS

A number of gem stones reportedly have been found in South Carolina, principally in the northwestern part of the state in association with rocks of the Inner Piedmont and Kings Mountain belts (Figure 1). Among these gem materials are beryl (aquamarine, emerald, yellow beryl), corundum (sapphire), diamond, garnet, quartz (amethyst, chalcedony, smoky, colorless), petrified wood, sillimanite, topaz, tourmaline, and zircon. Their localities are shown on Figure 2 and described in Table 2. There has never been any systemmatic production of gem materials in South Carolina, although small amounts have been collected and sold from time to time. Records of such production, therefore, do not exist. In 1959 production was limited to small amounts of sillimanite from Oconee County, tourmaline from Spartanburg County, and miscellaneous gem stones from Lexington County. There was no recorded production in 1960.

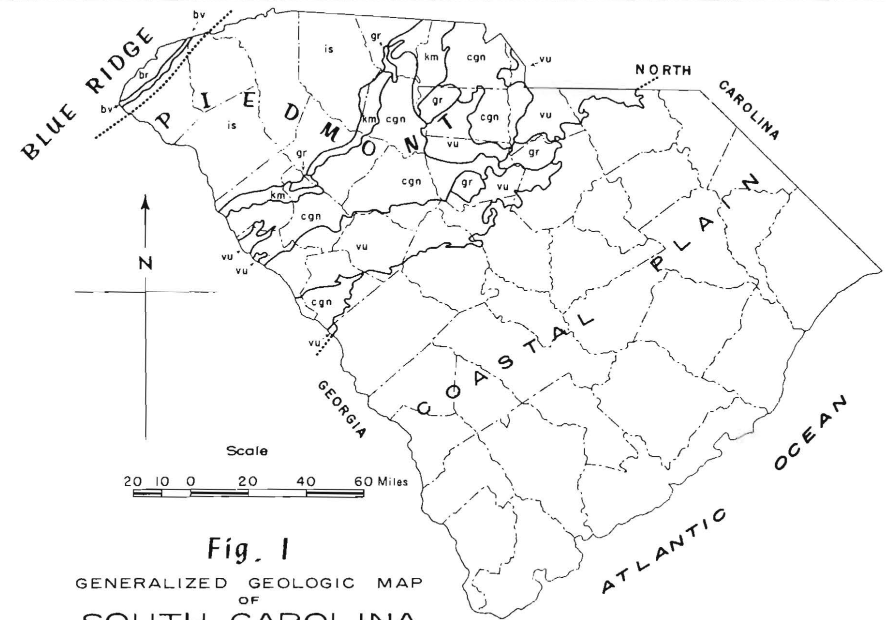

Fig. I

GENERALIZED GEOLOGIC MAP
OF
SOUTH CAROLINA

EXPLANATION

Coastal Plain Rocks
Unconsolidated sands and clays.

gr — Granite

vu — Carolina Slate Belt
Weakly metamorphosed predominantly schistose rocks derived from felsic to mafic volcanic flows and tuffs, interbedded with argillites and graywacke-type siltstones. Predominantly andesitic in character.

cgn — Charlotte Belt
Gneissic rocks of plutonic character, including hornblende and quartz-biotite gneiss, migmatites, discordant late orogenic granites, and small scattered gabbro plugs.

km — Kings Mountain Belt
Phyllites and schists containing distinctive bodies of marble, quartzite, kyanite quartzite, and conglomerate.

is — Inner Piedmont Belt
Granitic and mafic gneisses with numerous conformable granitic intrusives; lesser bodies of ultramafic rocks, (peridotite and dunite).

bv — Brevard Belt
Phyllites and schists with occasional lenticular beds of limestone.

br — Blue Ridge Belt
Gneissic and plutonic rocks.

Piedmont after Overstreet, W. C., and Bell, Henry, III, 1961, Provisional geologic map of the crystalline rocks of South Carolina: U.S. Geol. Survey Open-file report.

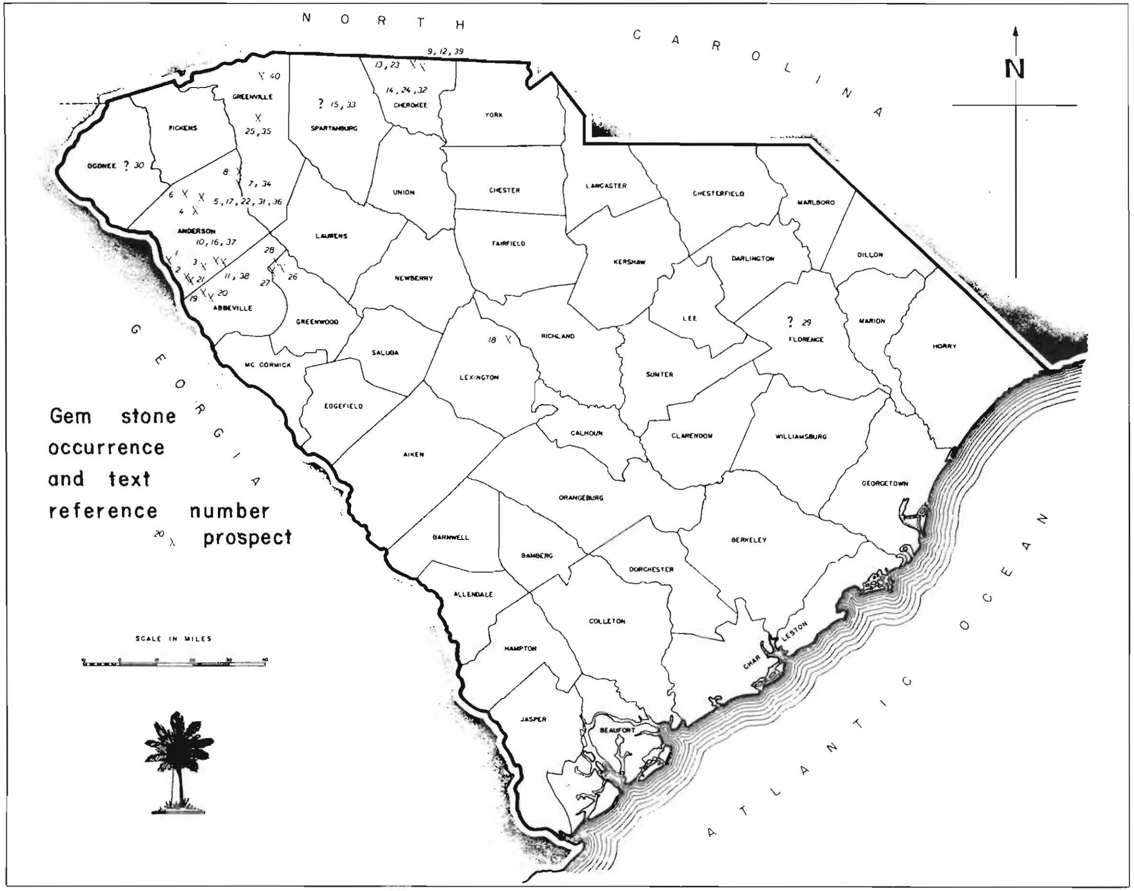

Fig. 2. Gem stone occurrences in South Carolina.

Beryl (Emerald)

Emerald is a transparent emerald-green variety of beryl. Its bright green color is due to the presence of a small amount of chromium. Fine, flawless emeralds are very rare, and come mainly from Muzo or Chivor, Colombia.

Emeralds occur in pegmatites and other granitic rocks, in crystalline schist, altered marble and in high-temperature calcite veins.

In the Southeast, emeralds have been found in North Carolina in Alexander County (Emerald-Hiddenite mine), Cleveland County (Turner mine), and in Mitchell County (Emerald matrix mine at Crabtree Mountain). Most of the emeralds found here were flawed and none of the mines are active now. At the Alexander County locality emeralds were found in schlieren in gneiss associated with hiddenite, aquamarine, rutile, black tourmaline, feldspar, and quartz. At the Turner mine about a dozen emerald crystals were found loose in the soil in association with black tourmaline and crystals of smoky and clear quartz. One pegmatite dike yielded a few small pale green emerald crystals from a red, clayey cavity in association with black tourmaline, feldspar, and green beryl (Schlegel, 1957, p. 210).

An emerald was reportedly found in Cherokee County, South Carolina (Locality 9), and beryl crystals approaching emerald in color were also found in Anderson County (Locality 5).

Beryl (Other Varieties)

Other gem stone varieties of beryl, valued for their color and transparency, are aquamarine, golden beryl (heliodor), morganite, goshenite, and common beryl. Beryl occurs in pegmatites, schists, gneisses, slates, and limestones. It occurs in hexagonal prisms from microscopic size to over one foot in diameter and several feet long, either as single crystals of gem quality or, more commonly, as clear, flawless areas in larger opaque crystals or masses (Ladoo and Myers, 1951, p. 102).

In South Carolina a few good crystals of beryl have been found in the pegmatites in Anderson County, and an occasional beryl specimen has been reported from Cherokee County in association with monazite sands.

Corundum (Ruby and Sapphire)

Ruby and sapphire are transparent red and blue varieties of corundum. The most valued color for sapphires is royal blue, and for rubies, "pigeon's blood" red. Star ruby and star sapphire display asterism, or six rays of light emanating from a center, due to the presence of small cylindrical cavities parallel to the prism planes. Although large sapphires are common, large rubies are rare. Colorless corundum is called "white sapphire" and the terms oriental emerald, oriental topaz, and oriental amethyst are used to designate green, yellow, and purple varieties of corundum respectively.

Schlegal (1957, p. 211) reports that "The only notable locality where rubies have been mined in the United States is Cowee Valley, Macon County, North Carolina. Here, the rubies probably were formed in a matrix of hornblende gneiss and pegmatite lenses in hornblende gneiss. Both the gneiss and pegmatite are badly weathered at the surface. In the decomposed pegmatite, pink to lilac-colored corundum is abundant, but little red corundum of gem quality has been found. Most of the gem material was obtained from nearby stream gravels. Associated minerals were all shades of corundum, ilmenite, rutile, kyanite, red and pink rhodolite garnet, and zircon. Gem rubies have also been found in the Calumet mine, Salida, Colorado; Marion Claim, Fremont County, Wyoming; and in Yoho Creek, Judith Basin County, Montana.

"Sapphires have been mined in many localities in Montana, the largest mine is near Yoho Gulch, Judith Basin County. The sapphires occur in a nearly vertical igneous dike that intrudes gently dipping limestone." Sapphire deposits also occur in California, Colorado, Idaho, Indiana, and North Carolina (at the Sapphire and White Water mine, Jackson County, and the Corundum Hill mine, Macon County).

In South Carolina sapphires have been reported from several localities in Cherokee County (Localities 12-14), and delicate shades of pink and blue corundum crystals have been reported from Anderson County (Localities 10-11).

Diamond

The diamond is composed of pure carbon and is the hardest known mineral. The uncut or rough diamond usually has a greasy, frosted appearance and often occurs in the shape of a rounded octahedron, difficult to recognize by untrained eyes. Crystals may range in size from microscopic to more than 3,000 carats, and vary in color, perfection, and value. The gem diamond must be transparent, have a desirable color, and be free from impurities. Diamonds possessing these qualities but of poor color are used for industrial purposes.

"The diamond occurs chiefly in alluvial deposits of gravel, sand, or clay, associated with quartz, gold, platinum, zircon, octahedrite, rutile, brookite, hematite, ilmenite, and also andalusite, chrysoberyl, topaz, corundum, tourmaline, garnet, etc.; the associated minerals being those common in granitic rocks or granite veins. Also found in quartzose conglomerates, and further in connection with the laminated granular quartz rock or quartzose hydromica schist, itacolumite, which in thin slabs is more or less flexible. This rock occurs at the mines of Brazil and the Ural Mountains; and also in Georgia and North Carolina, where a few diamonds have been found." (Dana and Ford, 1954, p. 396).

Although diamond discoveries have been reported from almost every state, the total production has been very small. The only notable occurrence of diamonds in the United States is near Murfreesboro, Pike County, Arkansas, where a small peridotite pipe has produced some diamonds of inferior quality, however, it has not proven economic to mine. Diamonds have also been found in the sand and gravel beds of streams and rivers on the Pacific Coast; in the glacial deposits of the Great Lakes region; in sand and gravel deposits of the Atlantic Coast–Piedmont region and in eastern Tennessee and central Kentucky (Schlegel, 1957, p. 209).

Only one diamond has been reportedly found in South Carolina (Locality 15). Mr. C. Leventhorpe mentioned in a letter to the New York Sun early in the 1880's that a fine white diamond, then valued at $400, was found in a South Carolina placer by D. J. Twitty (Mineral Resources, 1883 and 1884, p. 729-730). This may be the same diamond mentioned by Tuomey (1848, p. 79) that was found in the washings of a stream about 1835. It weighed 1 1/2 carats. The possible occurrence of diamonds in South Carolina in connection with itacolumite was mentioned by Tuomey (1848, p. 78), who noted two occurrences of itacolumite in South Carolina similar to those where diamonds had been discovered in Georgia and North Carolina. These were (1) near Limestone Springs about 100 yards north of the junction of Union Road and the road to Cherokee Ford, and (2) in Pickens District between West Union and Oconee Mountain on the land of Dr. McElroy.

Garnet

There are at least six different species of garnet: (1) grossularite (cinnamon stone, essonite), (2) pyrope (rhodolite), (3) almandite, (4) spessartite, (5) andradite (topazolite, melanite, demantoid), and (6) uvarovite. Almost every type of clear, transparent garnet is suitable for gem stones; however, the most popular varieties are the blood-red or firey-red pyrope, also called Anyma ruby, Bohemian garnet, or Cape ruby; the deep crimson almandite, also known as carbuncle; and the brilliant emerald green variety of andradite known as demantoid, the most valuable of all the garnets. Gem quality, deep-red spessartite is quite rare. Green uvarovite occurs in very small crystals which are used as jewels in watches. Grossularite is not as popular because of its color and imperfect transparency (Ladoo and Myers, 1951, p. 247; Schlegel, 1957, p. 216-217).

Garnet occurs as a common accessory mineral in crystalline schist, gneiss, and limestone, and in contact zones. It also is found in pegmatites; in various types of igneous rock, particularly in basic igneous rocks and their derivatives; and in stream gravels.

Occurrences of garnet are widespread throughout the United States. In the Southeast, garnet deposits have been found in Virginia (spessartite at Amelia Court House, Amelia County) and in North Carolina (rhodolite from Mason's Branch, Jackson and Macon Counties; essonite from Bakersville, pyrope from Laurel Creek, Burke County; and almandite from Avery, Burke, Caldwell and Catawba Counties).

In South Carolina, garnet occurs as isolated crystals in schists and gneisses of the Piedmont or as small grains in the sands and gravels of numerous streams. However, no garnet deposits of economic importance are known in South Carolina.

Quartz

Quartz comprises about 12 percent of the earth's crust and commonly occurs in silica-rich igneous rocks such as granite, pegmatite, or rhyolite; in metamorphic rocks such as gneiss; in sedimentary rocks, and in veins. It occurs in a variety of forms and colors. The varieties suitable for gem stone purposes are either coarsely crystalline or cryptocrystalline, such as agate or jasper.

Amethyst is pale orchid to deep purple in color, due probably to the presence of boron or manganese. The most precious amethyst is reddish-violet. In the Southeast, amethyst deposits occur in Virginia, Georgia (Rabun County), North Carolina (Alexander, Lincoln, and Macon Counties), and in South Carolina.

Quartz crystal, the transparent, colorless variety of quartz, has been found in almost every state in the Union. One of the better known localities is Herkimer County, New York. In the Southeast it is found near Rome, Georgia; in Alexander, Burke, Catawba, and Surrey Counties, North Carolina; and in South Carolina.

Smoky quartz varies in color from smoky yellow (cairngorm) to dark smoky-brown. In the Southeast, smoky quartz is found in Alexander, Burke, and Catawba Counties, North Carolina; and in South Carolina.

Chalcedony is opaque, translucent to transparent and has a waxy luster. It may be white, grayish, blue, brown or black in color and is cryptocrystalline. Petrified wood is quartz pseudomorphic after wood. It is formed by the replacement of wood by silica, generally opal or chalcedony, preserving the original form and structure of the wood.

In South Carolina, excellent amethyst crystals have been found in Abbeville, Anderson and Cherokee Counties. Nodular masses of chalcedony occur in the Coastal Plain, notably near Kings Creek Landing on the Savannah River. This chalcedony ranges in color through various shades of white, pink, and blue. Some pieces contain fossil coral. The Indians used chalcedony to make arrow heads and spear tips and fragments of these tools are abundant in the soil here. Crude amber occurs occasionally in the Coastal Plain as rounded lumps superimposed on phosphate rock, however, it does not occur in large enough quantities to be economic (Sloan, 1908, p. 158).

Sillimanite

Sillimanite is not as commonly used for gem purposes as those listed in Table 1. It occurs as long needle-like crystals, often bent or interlaced, or in fibrous or columnar masses. It may also occur as separate, stout prismatic crystals in schists. Sillimanite is gray, brown, yellowish or greenish and occurs as an accessory mineral in metamorphic rocks such as schists, gneisses, hornfels, or quartzose and micaceous slates. In 1958 and 1959 sillimanite crystals from Oconee County, South Carolina, were collected and sold.

Topaz

Gem topaz is transparent and vitreous, though not brilliant. It usually forms stout prismatic crystals with pyramidal faces at one end. The most preferred colors are pink, wine-yellow and pale blue. The gem variety differs from the massive variety, such as that which occurs at the old Brewer mine in Chesterfield County, South Carolina. There the topaz occurs in rounded masses resembling a gray siliceous chert.

Topaz often occurs in tin-bearing pegmatites, in veins and cavities in highly acid igneous rocks such as granites and rhyolites, and occasionally in contact zones of surrounding schists and gneisses.

Gem topaz has been found in the pegmatite areas of New England and San Diego County, California; in a number of localities in Colorado; in Streeter, Texas; and in the Thomas Mountain of Utah. In South Carolina topaz crystals have been reported from Anderson and Cherokee Counties (Localities 31 and 32).

Tourmaline

Tourmaline often occurs in well-developed hexagonal crystals, spherically triangular in cross section. Colors vary from black through blue, green, red and rarely white or colorless. Sometimes there is a zonal arrangement of colors within a single crystal. The best gem tourmaline is transparent, clear and vitreous alkali tourmaline.

It occurs in granites and pegmatites; in metamorphic rocks such as schists, gneisses, and crystalline limestones; and at the boundaries of granitic masses in association with quartz, microcline, muscovite, and albite.

Tourmaline has been found in pegmatites in New England, in New York, New Jersey, Pennsylvania, California, Colorado and Arizona. Especially notable are the red, green and pink crystals found in Oxford County, Maine, and San Diego County, California. In South Carolina tourmaline occurs as a common accessory mineral in pegmatites. It has been reported from Spartanburg, Anderson, and Greenville Counties (Localities 33-36).

Zircon

Gem zircon usually occurs as square prisms capped by pyramids or as irregular forms and rounded grains in sands and gravels. The transparent orange, reddish or brownish gem varieties are called hyacinth or jacinth, while the colorless or smoky varieties are called jargon.

Zircon occurs as a common accessory mineral in igneous rocks, especially granite, syenite, and diorite, commonly as minute crystals although large crystals are common in pegmatites. It occurs occasionally in granular limestone, schists, gneiss, and more commonly, in gold-bearing sands.

In South Carolina large zircon crystals occur near Tigerville in Greenville County, and scattered crystals of zircon have been reported from Anderson and Cherokee Counties.

Table 2: SOUTH CAROLINA GEM STONE LOCALITIES

Locality	Location	Discussion (Numbers in parentheses refer to sources)
	BERYL	
1. J. J. Fretwell mica prospect	Anderson County, NE bank of Savannah River about 1/4 mi. above mouth of Big Generostee Creek and 1 mi. S of Gaillard mica mine.	Blue-green to yellowish crystals of beryl were found in a pegmatite here. (1)
2. J. B. Alexander place	Anderson Co., 3.2 mi. SW of Iva.	Some beryl has been found here. (2)
3. Frank Pruitt place	Anderson Co., 1 3/4 mi. NE of Iva, just W of Wilson's Creek near S.C. Highway 413.	Yellow beryl has been reported here; a crystal of columbite (1 x 1 1/2 inches) was also reportedly found here. (4)
4. Anderson City locality	Anderson Co., Anderson City near Harrison Springs.	Some beryl has been found in this locality. (2)
5. J.N.S. McConnell place	Anderson Co., 3 1/4 mi. NE of Anderson.	Sloan (2) reported that good, clear green crystals of beryl (almost emeralds) and occasional topaz crystals occur in pegmatites here. The beryl occurred mainly as prisms penetrating feldspar. D. B. Sterrett (3) reported that by 1913, a trench 45 ft. long, 15 ft. wide and 5 ft. deep had been dug, and the pegmatite was not then exposed. Although the dumps contained no beryl, they did reveal rough crystals of smoky and colorless quartz, blocks of massive white quartz, large dark red garnet crystals, black tourmaline, kaolinized feldspar, limonite pseudomorphs after pyrite and black manganese oxide stains. Beryl is also reported from an area 1/2 mi. SW of McConnell place. According to Mineral Resources (1915, p. 847) ten pounds of pale blue beryl (broken crystals) were found on the surface and yielded some cut gems.
6. Martin-Blackwell-Ferguson mica prospect	Anderson Co., 5.7 mi. north of Anderson on U.S. Highway 178.	A fragment of semi-transparent beryl, almost aquamarine in color was found here. (4)

7. Pelzer Vicinity	Anderson and Greenville Co., (a) 1.5 mi. SW of Piedmont, (b) 1 mi. south of Pelzer.	Some fine specimens of beryl (aquamarine) and tourmaline have been found here. (2)
8. Cleveland mica prospect	Greenville Co., 7 mi. SSW of Greenville, west of S.C. Highway 20 and Piedmont and Northern and the Southern RR tracks; 1/2 mi. E. of Saluda River and due E of Oakvale Lake.	One crystal of rather clear, colorless beryl was found on the surface in association with a pegmatite. (4)
9. Andrew Moore place and vicinity	Cherokee Co., 2.5 mi. NW of Blacksburg, adjacent to Buffalo Church Road (Secondary road 83).	A fine emerald was reportedly found here. Sapphire and zircon are also reported in this locality. (2)
	CORUNDUM	
10. Thompson place	Anderson Co., 6 mi. N50°E of Cooks; 11 mi. SE of Anderson.	Corundum, occurring as tabular crystals in delicate shades of pink and blue, has been found along gullies on these two properties. (2)
11. Jackson place	Anderson Co., 11.5 mi. SE of Anderson.	
12. Andrew Moore place	Cherokee Co., 2.5 mi. NW of Blacksburg, next to secondary road 83.	Several good sapphires and scattered zircons have been found here in association with pegmatites or feldspathic rocks. (2)
13. W.T. Gibbons place	Cherokee Co., 0.7 mi. W of Buffalo Church and 4.5 mi. NW of Blacksburg	Corundum is irregularly distributed through hydromica slates, occasionally associated with good sapphires. Fine clusters of amethyst are reported near pegmatites here. (2) This occurrence was examined by J.F. McCauley in 1958 and no corundum crystals of gem quality were apparent on the surface. Most crystals found were riddled with inclusions.
14. Bowen River Basin	Cherokee Co., Bowen River drainage area, NW of Blacksburg.	Scattered specimens of corundum occur along the tributaries of Bowen River; among those found were a number of small sapphires, some small topaz crystals, and one fine green corundum crystal (called oriental emerald) from the vicinity of Porter's Hill. (2)
	DIAMOND	
15. Unknown	Spartanburg County ??	Mr. C. Leventhorpe mentioned, in a letter to the New York Sun, early in the 1880's, that a fine white diamond, then valued at $400 was found in a South

		Carolina placer by D. J. Twitty (Mineral Resources, 1883 and 1884, p. 729-730).
	GARNET	
16. Thompson place	Anderson Co., 6 mi. N50°E of Cooks, 11 mi. S70°E of Anderson	Deep red massive garnet occurs here irregularly distributed in a feldspathic matrix associated with pegmatite. (2)
17. J.N.S. McConnell place	Anderson Co., 3 1/4 mi. NE of Anderson.	Large dark red garnet crystals occur here with mica, rough crystals of colorless and smoky quartz, black tourmaline and beryl, and massive white quartz. (3)
18. Lake Murray Spillway	Lexington Co., Lake Murray Spillway 11 mi. from Columbia.	Small garnets have been eroded from garnet-bearing mica schist at the spillway and are concentrated in pockets along the channel.
	QUARTZ	
19. Barnes place	Abbeville Co., 1.8 mi. N of Lowndesville	Specimens of superior amethyst have been found here. (2)
20. McCalla place	Abbeville Co., E of Lowndesville.	Specimens of superior amethyst have been reported here. (2)
21. W.T.A. Sherad place	Anderson Co., near Moffettsville, S. of Iva.	"Amethyst of exquisitely clear color occurs in crystals, both individual and clustered. The Smithsonian Institution purchased some fine specimens from this locality. It occurs in narrow and apparently disconnected pockets in the mica slates." (2)
22. J.N.S. McConnell place	Anderson Co., 3 1/4 mi. NE of Anderson.	Rough crystals of smoky and colorless quartz occur here with blocks of massive white quartz, large dark red crystals of garnet and black tourmaline. (1)
23. W. T. Gibbons place	Cherokee Co., 0.7 mi. W of Buffalo Church and 4.5 mi. NW of Blacksburg	Fine clusters of amethyst are found in association with pegmatites. (2)
24. Bowen River Basin	Cherokee Co., Bowen River drainage area.	Fine crystals of amethyst occur in small veins in the mica slates. (2)
25. Boling mica prospect	Greenville Co., 5 mi. N of Greenville near the eastern end of Paris Mtn. State Park, 200 yards E of the road near the junction of Mountain Creek and the stream that crosses the park.	Crystalline clear and smoky quartz occurs in a pegmatite associated with mica, tourmaline crystals, and sillimanite. (4)

26. J. T. Algary place	Greenwood Co., 4 mi. SE of Donalds near Shoals Junction	Clusters of clear pale amethyst crystals have been found here, measuring up to 8 inches across, 3 inches thick, with individual crystals 2 inches thick. (3)
27. R. W. Dunn place	Greenwood Co., 1 mile SW of Shoals Junction and 3 mi. SE of Donalds.	Amethystine and colorless quartz crystals have been found in the fields here. (3)
28. R. M. Haddon place	Greenwood Co., 1 1/2 mi. SE of Shoals Junction and 3 mi. SE of Donalds.	Crystals of amethystine to almost colorless quartz have been found in a field near the road to Donalds. None of these surface specimens had sufficient depth of color to make desirable gem stones. (3)
	PETRIFIED WOOD	
29. High Hill Creek Area	Florence Co., High Hill Creek area.	Silicified wood common in Pee Dee River floodplain and terrace deposits in this area.
	SILLIMANITE	
30. Unknown	Oconee Co., locality not described.	Crystals of sillimanite were collected and sold to tourists and collectors in 1958 and 1959 from unspecified localities within the county. In 1959, 3 pounds valued at $300 were produced (Minerals Yearbook, 1959, p. 898).
	TOPAZ	
31. J.N.S. McConnell place	Anderson Co., 3 1/4 mi. E of Anderson	Occasional crystals of topaz occur with green beryl in pegmatites at this locality. (3)
32. Bowen River Basin	Cherokee Co., Bowen River drainage area.	Occasional small crystals of topaz have been reported along the tributaries of Bowen River along with corundum. (2)
	TOURMALINE	
33. Unknown Locality	Spartanburg Co., Unknown locality.	Ten pounds of black tourmaline crystals were produced for sale to tourists and collectors in 1959 (Minerals Yearbook, 1959, p. 899).
34. Pelzer vicinity	Anderson and Greenville Co., in the vicinity of Pelzer.	A few crystals of tourmaline with a fairly clear blue-green color have been found near Pelzer. It occurs with beryl and is disseminated through gneiss and mica schist and in quartz veins. (2)

35. Boling mica prospect	Greenville Co., 5 mi. N of Greenville near the eastern end of Paris Mtn. State Park, 200 yards E of the road near the junction of Mountain Creek and a stream that crosses the park.	Tourmaline crystals are present at this locality in association with pegmatite. (4)
36. J.N.S. McConnell	Anderson County, 3 1/4 mi. NE of Anderson.	Black tourmaline has been reported here in association with beryl, quartz, garnet, mica, and feldspar. (3)
	ZIRCON	
37. Thompson place	Anderson Co., 6 mi. NE of Cooks and 11 miles SE of Anderson.	Zircon occurs with corundum along gullies on these two properties. Zircon occurs as short prisms with pyramidal terminations and as geniculated twins. (2)
38. Jackson place	Anderson Co., 11.5 mi. SE of Anderson.	
39. Andrew Moore place	Cherokee Co., 2.5 mi. NW of Blacksburg, next to secondary road 83.	Scattered zircons have been reported here. (2)
40. Tigerville vicinity	Greenville Co., 12 mi. NW of Greer near Tigerville.	Large crystals of zircon have been found in place at the old vermiculite mines or creek bottoms in the vicinity.

Sources: (1) Griffitts and Olson, 1953, p. 301-302, 324.
(2) Sloan, 1908, p. 151-158.
(3) Sterrett, 1914, p. 655-663.
(4) Teague, Unpublished Manuscript

USES

Gem stones are used essentially for decorative purposes in jewelry and to a lesser extent in art objects such as vases and statuettes. In addition, gem stones are important in a number of industrial applications.

More than 80 percent of all diamonds now produced is used for industrial purposes, principally as grit and powder for use in grinding, cutting, shaping, and polishing glass, porcelains, and other hard materials, and for sharpening tools. The rest of the annual world production of industrial diamonds is used in drill bits, for dressing grinding wheels, and in preparing shaped tools and wire-drawing dies.

Synthetic corundum, spinel, and hard glasses have largely displaced gem stones for use as jewel bearings; but natural diamond, ruby, and sapphire are still used for precision bearings of the highest quality. Sardonyx and garnet are sometimes used for large, relatively inexpensive bearings. Some ruby and sapphire also is used in gauges, dies, phonograph needles, and combustion chamber windows.

Fluorite, gypsum, calcite, tourmaline, and clear unflawed quartz crystal have a number of important uses in optical instruments or electronic devices. However, tourmaline and calcite are being increasingly replaced in many optical uses by the artificial material Polaroid.

In addition to the many other industrial uses of gem stones, some hard gem materials such as corundum, garnet, and quartz are suitable for abrasive purposes but now have been largely replaced by synthetic materials and less expensive natural materials.

PROPERTIES OF GEM STONES

Gem stones are valued for their beauty or splendor, durability, rarity, portability, and cut or "make." The beauty of a gem stone depends on its color, transparency, indicies of refraction, dispersion, and visible perfection.

Color is especially important in opaque stones or transparent gems with low or moderate indicies of refraction. The most consistant color preferences are red, blue, green, and violet to purple. Desirable features are eveness of coloring or, in the case of some ruby, sapphire, garnet, and tourmaline, distinct color zoning. Color banding, streaking or mottling of nontransparent gem stones is also desirable, as found in agate, sardonyx, tiger-eye, and other types of cryptocrystalline quartz.

The indicies of refraction of gem stones are responsible for the brilliance shown by some stones. These indicies are a measure of the degree to which light rays are bent when passing through crystalline material. They are very high in diamond, rutile, zircon, and other stones characterized by their brilliance when cut properly. The power of dispersion shown by some minerals such as diamond, sphalerite, rutile, sphene, zircon, and some varieties of garnet, cause the shifting changes of color called fire. Another important property in translucent gem stones is pleochroism, which affects the hue, tone, or both when viewed in various directions by transmitted light.

Gem stones that are harder than quartz are superior for use in jewelry because they are resistant to abrasion and retain their polish despite daily wear. Softer minerals, although used for jewelry, generally lose their polish and sharpness through prolonged wear unless they are handled carefully. A few minerals such as jadeite, nephrite, and sillimanite, although softer than quartz, are tough and resistant to wear and are used satisfactorily in jewelry. The most desirable gem stones for use in jewelry, however, are diamond, chrysoberyl, corundum, spinel, topaz, and most varieties of beryl, garnet, tourmaline, and zircon (Jahns, 1960, p. 393-397).

MINING AND BENEFICIATION METHODS

Many gem stone deposits have been discovered accidentially, some in connection with other mining operations or exploration for other substances. After the initial discovery, unconsolidated stream gravels and other placer deposits in the vicinity are usually examined for any gem stone content. Placer deposits and fragments of surface float can sometimes be traced to their source, although some lode deposits have been found through prospecting certain types of bedrock. Most exploration for domestic gem stone deposits is now done by individual prospectors and amateur collectors.

Placer gem stone deposits are commonly worked by hand labor, with shallow pits, drifts, and shafts. Larger operations use bulk-handling methods such as sluices, power shovels, dredges and drag-line scrapers. Lode deposits are usually mined by making open cuts in the gem-bearing areas. The mining of most pegmatites is generally confined to working mineralized pockets near the surface as simply as possible. Cheap labor is generally necessary, and most large gem mines are therefore in relatively undeveloped parts of the world.

The most common methods of concentrating materials removed from lode or placer gem deposits is by washing, winnowing, screening, panning, jigging, tabling, hand-picking, and a number of combinations of these. Large scale operations usually employ mechanical methods of separation (Jahns, 1960, p. 407-415).

PRICES

The carat (205 mg) is the standard unit of weight for the more valuable gem stones. Small diamonds may be measured in points (100 points equals 1 carat). Less expensive gem material such as feldspar, quartz, and turquois is sold by the gram, kilogram, avoirdupois ounce, troy ounce, or pound. The standard unit of measure for pearls is the pearl grain, which equals 1/4 carat.

Jahns (1960, p. 426-432) sets forth a table listing the average retail price ranges of cut, unset gem stones for the major minerals. The table indicates the relative prices of individual stones or small groups of stones during 1950-1957, based on size, color, and other features. These values, however, are not standardized, and may vary considerably within the trade. A more recent price list for quality cut and polished gem stones was published in 1960 (Guffy, Neal, 1960, Gem Appraisers' Guide: Lapidary Jewelers, Inc., Washington, D. C., 56 pp.).

There is a scarcity of large rubies of excellent quality as well as large cat's-eye, spinel, and some tourmaline of top quality. "Transparent andalusite, diopside, epidote, kyanite, and sphene, in the form of cut gems of good to excellent quality, now command retail prices of $2 to about $50 per carat, depending upon size and color of the individual stone. Benitoite is currently in great demand, and stones larger than one carat are being sold for $50 to $130 per carat. Most of these minerals are rare in transparent crystals, and finished gems in sizes above 3 to 5 carats are extremely difficult to obtain in any color or quality. Prices for 10- to 15-carat stones of most nontransparent minerals, including datolite, feldspathoids, hematite, idocrase, marcasite, prehnite, pyrite, rhodonite, serpentine, smithsonite, variscite, and zeolites, range from $5 to $30 per stone according to quality. Most amber is in the same price category, lapis lazuli is somewhat more expensive, and natural glasses are less expensive.

"The retail price of cut synthetic emerald of good color... ranges from $20 to $100 for 1-carat stones. ... Cut synthetic rutile commands prices of $8 to $20 per carat in the 1- to 10 carat size range; the most expensive stones are those that are least yellowish in color. Boules of transparent ruby, sapphire, and spinel are sold for less than a dollar a carat, so that the cost of finishing gems is mainly that of cutting and handling. Prices are about $2 to $12 per stone for most sizes. Finished gems of synthetic star ruby and star sapphire are being sold for $10 to $18 per carat in the 1- to 10-carat size range" (Jahns, 1960, p. 434-435).

RESERVES

Deposits of gem stones are widespread throughout the world, occuring in every continent. Ninety-eight percent of the free-world reserve of gem diamond, estimated to be 50 million carats, is in Africa. Data on the world reserves of other gem stones are not available (Hartwell, 1960, p. 338).

The United States has no significant reserves of diamond, emerald, ruby, or sapphire and estimates of the reserves of other gem stones are unreliable. Domestic deposits of gem stones are noted more for their variety than for their economic importance.

Approximately 75 varieties of gem stones have been produced in the United States, notably benitoite (California), chlorastrolite (Lake Superior Region), and rhodolite garnet (North Carolina). In addition, the quality of a number of other gem stones has made them desirable: amazonite from Colorado, Pennsylvania, and Virginia; amethyst from Arizona; beryl from Colorado and Maine; black opal from Nevada; beryl and hiddenite from North Carolina; jade from Wyoming; tourmaline from Maine; variscite from Utah; beryl, kunzite, gold quartz, and tourmaline from California; moss agate from Montana and Wyoming; azurite, malachite and various others from several Western States (Ball, 1937, p. 307; Jahns, 1960, p. 407).

SYNTHETICS

Among the synthetic gem stones that have been developed are corundum, spinel, emerald, and industrial diamond. Synthetic corundum and spinel (fused aluminum oxide), essentially similar in composition and properties to the natural minerals, can be economically and almost flawlessly produced, evenly and attractively colored. Synthetic star ruby and star sapphire have also proven quite popular. A variety of synthetic spinel resembling lapis lazuli has also been produced.

Synthetic emerald crystals weighing up to 1,000 carats have been produced almost equalling the properties of natural emeralds. Though they are expensive, the synthetic emeralds are very popular.

Synthetic industrial diamonds have also been produced, but their cost is still high in comparison with natural diamond. In 1957 boron nitride (Borazon) was successfully converted to its cubic form, which has about the same hardness as diamond. It performs as well as diamond powder in polishing diamond surfaces.

In addition, synthetic rutile (titania), chrysoberyl, quartz, fluorite, tourmaline, and other minerals have also been made synthetically but for reasons of expense, unsuitability as gems, or inferior hardness, have not attracted much attention as gem materials. Glass imitations can be made of beryl, jade, quartz, topaz, tourmaline, diamond, ruby, sapphire, zircon, and pearl; however, these are suitable only for costume jewelry because of inferior hardness (Jahns, 1960, p. 415-417).

OUTLOOK

The United States is expected to have a continuing adequate domestic supply of semi-precious gem stones, but it will have to continue to rely on imports for its supply of precious stones.

The United States imports and uses more gem materials and industrial gem stones than any other nation. In 1960, $192 million worth of gem stones, not including industrial diamonds, were imported. Since 1950, the United States has imported 85 percent of the total world production of industrial diamond, 40 percent of the world output of rough gem diamond, and about 75 percent of the cut diamonds. Comparable figures apply for many other valuable gem stones. In addition, more than half of the cultured pearls produced by Japan since World War II has been imported to the United States.

There are no import duties on rough or uncut natural stones for either gem or industrial use. An import duty of 10 percent ad valorem is placed on cut diamonds and other natural precious gem stones in cut form and for natural or cultured pearls. The import duty on cut or faceted non-opaque imitation stones is 20 percent and up to 60 percent for many other imitation gem materials (Jahns, 1960, p. 423-425.

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