GEM LOCALITIES OF THE 1990S

By James E. Shigley, Dona M. Dirlam, Brendan M. Laurs, Edward W. Boehm, George Bosshart, and William F. Larson

The past decade saw growth in gem exploration, production, and marketing worldwide. Important colored stone–producing regions included: Southeast Asia (Myanmar, Thailand, and Vietnam), Africa (Tanzania, Kenya, Zimbabwe, Nigeria, and Namibia, as well as Madagascar), South America (Brazil and Colombia), central and southern Asia (Sri Lanka, India, Afghanistan, Pakistan, Russia, and China), and Australia. The major sources for diamonds were Australia, central and southern Africa (Botswana, South Africa, Namibia, Angola, and Zaire), and Russia (mainly in the Republic of Sakha), with exciting discoveries in northern Canada. Cultured pearls from French Polynesia, Australia, and China became increasingly important, as production from Japan declined. This article provides a comprehensive overview of those gem deposits that were either new or remained commercially significant in the last decade of the 20th century.

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During the 1990s, new finds of gems created interest and excitement among both jewelers and consumers. These included ruby from Mong Hsu, Myanmar (Burma); blue and pink sapphires from Madagascar; a wide variety of colored stones from southern Tanzania; spessartine garnet from Nigeria and Namibia; exceptional peridot from Pakistan; and pink to red tourmalines from Nigeria and Brazil. Diamond was mined in northern Canada for the first time. Names such as *Tunduru*, *Ilakaka*, and *Ekati* were unknown to the gem trade in the 1980s, and yet they are now commonplace when we speak of important gem localities at the dawn of the 21st century. Through the efforts of independent prospectors and small groups of miners, as well as multinational exploration companies—stimulated by strong consumer demand—the 1990s witnessed a proliferation of gem sources. Gem localities continue to intrigue consumers because they create an integral part of the romance and lore that are associated with gemstones, an opportunity to purchase a symbol of beauty and rarity from a remote land (figure 1).

This article updates the 1980s survey published by Shigley et al. in the Spring 1990 Retrospective issue of *Gems & Gemology* by identifying key localities discovered during the past decade, and highlighting deposits that either attained or continued at commercial levels of production during this period. We have also included newer or less-explored localities that may have potential in the future. Most of our coverage is limited to the more commercially important gem materials (i.e., emerald and other beryls, alexandrite and other chrysoberyls, ruby and sapphire, diamond, garnet, jade [both jadeite and nephrite], opal, peridot, quartz, spinel, tanzanite, topaz, and tourmaline). Locality information is both summarized in the text and listed in greater detail in table 1 at the end of the article. In table 1, the more commercially significant localities (according to our best understanding) are designated in bold type; citations are to the most relevant articles

Figure 1. Several new gem sources joined traditional localities as important producers in the 1990s. The sapphires and rubies in this necklace come from a number of sources, but predominantly Sri Lanka. Accented with smaller diamonds, the 129 gem corundums have a total weight of 280.45 ct. Jewelry manufactured by Wilson Benito; courtesy of Richard Stoich and Quyen Cao. Photo © Harold & Erica Van Pelt.

on each locality for convenient reference (personal communications are used where published information is not available). In addition, selected localities are plotted on five maps (see enclosed chart) that show several major gem-producing regions (southern Africa, South Asia, Southeast Asia, Australia, South America). Although there has been some notable production in the areas omitted (e.g., Russia, North America, western Africa, and China), they were less significant—in terms of the variety of gems produced—during this decade than localities in the five regions mentioned. Separate lists are provided for localities producing less-prominent gems (i.e., apatite, benitoite, charoite, chrome diopside, feldspar, iolite, lapis lazuli, maw sit sit, red beryl, rhodochrosite, rhodonite, scapolite, sphene, spodumene, sugilite, turquoise, and zircon), as well as for regions important for cultured pearls; see tables 2 and 3, respectively, also at the end of the article.

SOURCES AND PRESENTATION OF INFORMATION

The gem locality information in this article comes from four main sources:

1. Published articles in the scientific and trade literature
2. Personal communications with individuals who are directly involved with gem mining or who purchase gem rough at mining sites
3. The authors' knowledge about the sources of commercially significant gem materials encountered in the trade during the past decade, including information on the kinds of gems that were submitted to the GIA Gem Trade Laboratory and the Gübelin Gem Lab
4. Visits by the authors to some gem-mining locations

Information for each locality is referenced according to what we deemed to be the best and most recent publications. However, the commercial significance of a gem locality is not always matched by the quantity or quality of relevant published information. Thus, over the past decade, published articles are lacking for some major gem deposits (especially those that have been mined for a considerable period). In such cases, earlier literature references are cited in the tables, or the listing of the locality is based on knowledge of the authors or respected colleagues. For gem localities of the 1980s where significant mining has continued, the literature citations in Shigley et al. (1990) are still valid (but are not given again here for brevity). Rather than cluttering the text with references, we decided to give most of the published citations primarily in the three tables. Again for the purpose of brevity, in the text we discuss most of the locality information with a general reference to the country rather than to the specific mine or region. For more on the specific localities, consult tables 1, 2, and 3.

There may be inconsistencies in spellings and diacritical marks (e.g., accents, umlauts, etc.) when some locality names are translated into English. We used the *Microsoft Encarta 99 Virtual Globe* software program, which is an electronic atlas, as a guide to both geographic information and locality name spellings.

In the text below, the gem materials are presented alphabetically, but within each category, the most important subgroup is mentioned first.

A separate box A is included to give the reader an

Figure 2. Colombia has remained the world's most important source of fine emeralds. The Colombian emerald in this pendant weighs 8.40 ct. Courtesy of H. Stern; photo © Harold & Erica Van Pelt.

idea of prices for some key gem materials during the '90s. This box was prepared by Richard Drucker, publisher of *The Guide*, which provides diamond (bimonthly) and colored stone (biannually) wholesale pricing information based on market activity. While *Gems & Gemology* does not typically report gemstone prices, those authors who are involved in the trade (EWB and WFL) believe that the figures given in box A are a good general representation of average prices during the past decade for the gems described.

Figure 3. Saturated-color aquamarine comes from relatively few deposits, and Africa was the most important source of this material during the 1990s. These aquamarines (9.05 and 4.90 ct) are from Mozambique. Courtesy of Steve Avery; photo by Robert Weldon.

BERYL

Emerald. Colombia still reigned throughout the 1990s as the principal source of fine-quality emeralds (figure 2), with the mining districts at Muzo and Coscuez, and to a lesser extent at Chivor, accounting for most production. In each of these districts, there are ongoing efforts to modernize mining operations to increase yield. Geologic studies of the Colombian emerald deposits have led to new insights into conditions of emerald formation by crystallization from hydrothermal solutions (see, e.g., Ottaway et al., 1994; Giuliani et al., 1995, 2000). Decreasing reserves at the historic mines have prompted active exploration in this region (Schwarz, 1999).

Emerald mining also continued at traditional sources in Brazil and Africa. Large quantities of Brazilian emeralds entered the market in the early '90s, particularly from Goiás and Minas Gerais (primarily the Nova Era area). By the middle of the decade, however, there was an abrupt decline from Minas Gerais due to decreased reserves and reduced demand. Emerald production in Brazil has since continued to decline.

Several sources in Africa produce attractive emeralds. Zimbabwe's Sandawana mine is noted for small stones (0.05 to 1 ct) of high quality. Madagascar and Zambia tend to produce cleaner but slightly darker emeralds than the deposits in Colombia; however, cut stones over 5 ct are quite rare.

Considerable excitement was generated in the early 1990s by renewed activity at the historic emerald mines in Russia's Ural Mountains (e.g., Schmetzer et al., 1991), but these mines never redeveloped into the important commercial sources that they once were.

Deposits in Afghanistan (Panjshir Valley) and Pakistan (Swat Valley) produced fine-quality emeralds of small average size, but mining activities were limited by economic (i.e., lack of profitability) and sociopolitical factors in both countries.

During the past decade, surface-reaching fractures in many emeralds were filled with a wider variety of oils (including cedarwood oil) and resins (such as Opticon and "Palma"), and the infilling process became a major topic of discussion in the trade. Due to concerns over the disclosure of this treatment and the durability of the substances used,

there was a decline in the overall demand for emeralds and in their prices during the latter half of the decade (Weldon, 1997; see also box A). This was especially a problem for emeralds from Colombia and Brazil, which led to greater market demand for African emeralds. The latter generally have fewer fissures, and thus they are less likely to have been treated. By the end of the decade, however, dealers reported that the market for Colombian emeralds had begun to improve.

Aquamarine and Other Beryls. The major sources of gem aquamarine continued to be the same as those of the previous decade, with numerous deposits in Brazil providing much of the supply (although material of African origin was also being imported into Brazil for cutting and reexport). The African sources were Nigeria, Mozambique (figure 3), Zambia, and Madagascar. In particular, the availability from Zambia and Mozambique of fine, saturated-color aquamarine that required no heat treatment helped revitalize the market for this material, which had suffered from declining demand when large quantities of irradiated blue topaz created an inexpensive alternative during the 1980s. Pegmatite miners working in the Lukusuzi game park area in Zambia (bordering Malawi and Mozambique) used creative methods to obtain aquamarine without explosives: They built fires under massive aquamarine-bearing quartz bodies, and then threw water onto the heated rock to fracture it, thereby facilitating the removal of the aquamarine (M. Sarosi, pers. comm., 1999). In general, most aquamarine is heat treated to improve its color.

Production of other beryl varieties (morganite and heliodor) also continued at previously known deposits. Large greenish yellow heliodor crystals from the Ukraine were heat treated to produce aquamarine. Although initially available in large quantities, the stockpile of these crystals was exhausted by the mid-1990s. The interest shown, and investments made, by major mining companies led to increased production of red beryl (figure 4) from the Wah Wah Mountains in southern Utah. Due to its dramatic red color, there was significant demand for this material in Japan. Marketing of red beryl under the trade name "Red Emerald" created controversy toward the end of the decade (Weldon, 1999).

CHRYSOBERYL

The major sources of chrysoberyl (including both cat's-eye [figure 5] and alexandrite) continued to be

Figure 4. Gem-quality red beryl continues to be mined from just one deposit in the Wah Wah Mountains of southern Utah. During the '90s, several mining companies leased the deposit for exploration, evaluation, and production. The bracelet shown here was designed and manufactured by Ray Zajicek/Equatorian Imports, and features 21 red beryls (0.3–0.8 ct each). The ring, designed by Paula Crevoshay, features a 1.66 ct red beryl accented with diamonds. Bracelet courtesy of the Harris family, and ring courtesy of Red Emerald Ltd.; photo by Maha Tannous.

Figure 5. Cat's-eye chrysoberyl is among the most prized of phenomenal stones; the cabochon in the ring on the bottom left weighs 5.95 ct. The other three rings are set with star rubies from Myanmar (7.90, 6.02, and about 15 ct, from bottom right to top left). Photo © Tino Hammid and Christie's Hong Kong.

Figure 6. In Myanmar, rubies are mined from both primary and secondary (alluvial) deposits. At these alluvial workings near Mogok, a series of claims are explored by small groups of independent miners. Photo by Edward Boehm, March 1993.

the alluvial gem fields of Sri Lanka and the pegmatite districts of Brazil. Efforts were underway to reopen some of the classic occurrences of alexandrite in Russia's Ural Mountains, but so far there has been only limited production from mine dumps (N. Kuznetsov, pers. comm., 2000). The most exciting new source of chrysoberyl—including a vanadium-colored green variety as well as alexandrite—has been the Tunduru region of southern Tanzania, which has produced an amazing variety of colored stones. Since late 1998, significant amounts of chrysoberyl (including cat's-eye material and alexandrite) have also been recovered from the Ilakaka alluvial deposit in southern Madagascar. Toward the end of the decade, sources in India (both in Orissa and Andhra Pradesh) provided new discoveries of green cat's-eye chrysoberyl as well as alexandrite.

CORUNDUM

Ruby. The 1990s witnessed continued supplies of ruby from the Southeast Asian countries that historically have been important sources (i.e., Myanmar [figures 5 and 6], Cambodia, and Thailand, with significant decrease in the last; Kane, 1999). In addition to new mines in the traditional Mogok region (Kane and Kammerling, 1992), a major new locality was discovered in Myanmar's Mong Hsu area (Peretti et al., 1995), with millions of dollars worth of ruby from this area entering the market in the past eight years. These rubies typically require heat treatment to remove their distinct blue core. The authors have seen large quantities of fine-color faceted Mong Hsu rubies, usually from 0.5 to 3 ct (see, e.g., figure 7). However, one of us (GB) knows of a substantial number of gem-quality Mong Hsu crystals that weighed well over 100 carats and yielded faceted rubies from 10 to 30 ct.

Figure 7. The most important ruby discovery of the 1990s was in the Mong Hsu region of Myanmar, where enormous quantities have been mined. The crystal shown here is 1.3 cm tall, and the faceted stone weighs 1.16 ct. Courtesy of Pala International; photo © Jeff Scovil.

India and Africa continue to produce primarily cabochon-quality material. African sources include several localities in Kenya, Tanzania, and Madagascar. In particular, the John Saul mine in

Kenya began producing large quantities of (mostly cabochon-grade) ruby after it was reactivated in the mid-1990s (Emmett, 1999b). The ruby occurrences in Malawi, Russia, Nepal, Afghanistan, Pakistan, and China have had little commercial impact to date, but they may prove significant in the future.

The enormous quantity of heat-treated ruby from Mong Hsu that flooded the market in the mid-1990s—as well as the introduction of smaller amounts of Vietnamese material beginning early in the decade—resulted in distinctly lower prices (Federman, 1998; see also box A). Although this decline in price created renewed demand for commercial-quality ruby, the growing prevalence of heat-treated ruby that contained residues of flux materials in healed fractures (see, e.g., Emmett, 1999a) also raised concerns about correct identification and disclosure for gem dealers and consumers alike. During this period, a significant price disparity developed between untreated and treated rubies (Federman, 1998).

Figure 8. A wide variety of colored stones were mined from large alluvial deposits in the Tunduru area of Tanzania, which were discovered in the mid-1990s. These pink and orange sapphires from Tunduru range from 2.78 to 8.33 ct. Courtesy of James Alger Co.; photo by Robert Weldon.

Sapphire. As with ruby, much of the sapphire on the market originated from Southeast and southern Asia (Thailand, Cambodia, Myanmar, Vietnam, and Sri Lanka; again, see figure 1). Although mining continued in Australia, a major producer in the 1980s, production was down significantly by the end of the decade (Aboosally, 1998).

East Africa, particularly the Tunduru region (figure 8), and several areas in Madagascar (figure 9) emerged as the most important commercial sources of blue and pink sapphire. Deposits near Ban Huai Sai in Laos produced primarily smaller, medium to dark blue sapphires that satisfied some of the demand for commercial-grade melee. The output of blue and fancy-color sapphires from Montana in the U.S. fluctuated greatly, with significant quantities produced during the middle of the decade. The gems occurred in a wide variety of colors, in sizes typically

Figure 9. One of the most important gem discoveries of the decade occurred in south-central Madagascar at Ilakaka. Like Tunduru, these extensive alluvial deposits yielded several varieties of colored gems. Here, miners wet-sieve sediments in the Ilakaka River before removing gem minerals by hand; photo by Brendan M. Laurs, December 1999. Fine sapphires, such as the one that produced the 7.32 ct untreated Malagasy stone shown in the inset, are sometimes recovered. Sapphire courtesy of JOEB Enterprises and Pala International; photo © Harold & Erica Van Pelt.

BOX A: GEM PRICES IN THE 1990S

Compiled by Richard Drucker, Publisher, *The Guide*

Since there is not a universally accepted grading scale for colored stones as there is for diamonds, grading and pricing for these gems is more subjective. *The Guide*, an internationally recognized gemstone pricing publication, conducts research with a qualified staff of advisors and research assistants who monitor trade shows, business transactions, and trading networks. For consistency in pricing, *The Guide* has used a comprehensive four-tiered grading scale for nearly 20 years: *Commercial* at the low end, *Good* and *Fine* in the middle, and *Extra Fine* at the high end. For the present analysis, the two middle categories (*Good* and *Fine*) are reported, as they are likely candidates for "jewelry quality." Prices can be considerably higher or lower for the other two categories.

The prices reported here are average wholesale, per the weight unit indicated (all January months for the years 1990–1999). Trends for specific gem varieties are described below, with the prices of major gems graphed in the accompanying charts (figure A-1). Although a gem's locality can play a role in pricing (such as a Burmese ruby or Kashmir sapphire), the information in this box is based on quality only. A Burmese ruby is priced separately in *The Guide*, and is not considered in the charts presented here. Likewise, the sapphire prices summarized in this box are for material from any locality except Myanmar (Burma) and Kashmir. Emerald prices are also generalized, recognizing that some top-quality Colombian emeralds may be priced higher.

Treatment is an important issue in pricing today. Normal (i.e., "traditional") treatments are assumed in pricing, since most gems on the market have undergone some treatment process (for example, the blue color in most aquamarine is produced by heat treatment, as is the blue in most tanzanite). Both ruby and sapphire are assumed to have been heat treated. Excess "glass" residue in the fissures and fractures of a ruby—which results from the use of a flux or other "firecoat" during heat treatment—can lower the value. Fissures in emeralds are typically filled with oil or resin, and the prices here assume a moderate level (i.e., extent) of treatment.

Following is a summary of the data for key gem materials in the 1990s.

Beryl—Emerald. Due to widespread concern over treatments, emeralds lost about half of their value (on average) over the decade (figure A-1, bottom). In recent years, a better understanding of treatments, as well as more comprehensive and descriptive reports of treated emeralds from gem-testing laboratories, appear to have halted the steady decline in prices.

Beryl—Aquamarine. Prices for aquamarine were fairly stable in the 1990s (e.g., at $100–$125/ct for "good" 3 ct stones). Increases in supply and new sources occasionally brought some prices down.

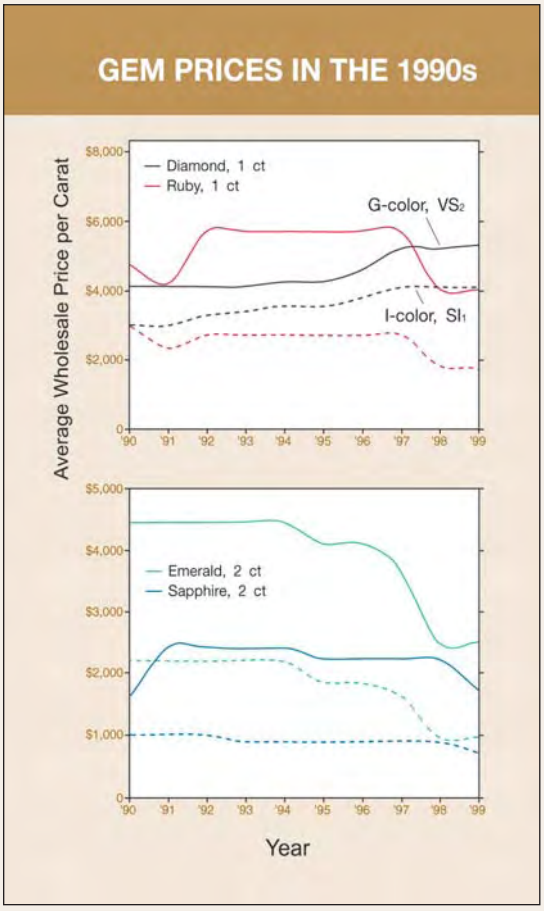

Figure A-1. Average wholesale per-carat prices in the 1990s (for the month of January) are shown for diamond and ruby (top), and sapphire and emerald (bottom). The Guide *categories* Good *(dashed lines) and* Fine *(solid lines) were selected as an index to "jewelry-quality" material. Prices may be considerably higher or lower for other quality grades.*

Corundum—Ruby. As was the case with emeralds, ruby prices were also hurt by controversy over treatments. Not only did the vast deposits discovered at Mong Hsu lead to the greater availability of fine material, but the presence of "glass" residue from the heat treatment of these stones in particular has caused ruby prices to decline over the past three to four years (figure A-1, top).

Corundum—Sapphire. Although sapphire largely escaped the treatment controversy, prices declined recently (figure A-1, bottom) due to the tremendous quantity of stones from Madagascar that have entered the marketplace.

Chrysoberyl—Alexandrite. Long a collector's stone, alexandrite has never been in plentiful supply. When Brazilian miners hit a pocket of alexandrite in 1991, supply increased and, contrary to what was expected, prices went up. Since then, the prices of lower-to-middle grades have remained fairly constant (at about $4,500/ct for 2 ct "good" stones), whereas finer-quality gemstones strengthened in price (from an average low of $5,750/ct in 1990 to $8,000/ct in 1999 for 2 ct "fine" stones).

Diamond (1 ct; G-color VS_2 and I-color SI_1). After an early 1990 price hike by De Beers—which was only partially reflected in diamond prices due to price resistance and absorption by suppliers—prices remained stable, with no official increases until a small one was implemented in early 1993. The period 1995–1997, however, saw larger and more frequent price increases (figure A-1, top). The end result was diamond prices about 30% higher at the end of the decade, especially in the more popular jewelry grades (e.g., $5,300 for 1 ct G-color VS_2 stones in 1999, as compared to $4,100 in 1990).

Garnet—Rhodolite. Rhodolite experienced fluctuating popularity, but its supply was steady and so were its prices (i.e., an average of $25 to $45/ct for "good" and "fine" 3 ct stones).

Quartz—Amethyst. Synthetic amethyst plagued the industry prior to 1990. Today, the problem still exists, but is mostly ignored at the retail level. Nevertheless, wholesale prices of natural amethyst slowly declined over most of the '90s (e.g., from an average of $20/ct down to $12/ct for "fine" 3 ct stones). This was perhaps due to the lack of widespread testing of amethyst and thus the salting of "natural" parcels with synthetic stones.

Spinel—Blue. Prices rose dramatically during the 1990s (e.g., from $125/ct to $350/ct for "fine" 3 ct stones), due to the increased popularity of blue spinel as a nonenhanced alternative to sapphire.

Spinel—Red. Considered by dealers to be an undervalued alternative red gemstone, prices remained stable (e.g., at an average of $200–$250/ct for "good" 2 ct stones), primarily due to a general lack of notoriety. In the mid-1990s, small price increases appeared for finer-quality red spinels, but price resistance eventually negated such gains.

Topaz—Imperial. This variety of topaz was a definite attraction in the tourist markets of the Caribbean, but not a great seller in the U.S. Overall, miners and jewelry stores were successful in raising the popularity and the price of Imperial topaz—by the end of the decade, up to $400/ct for "fine" 3 ct stones in yellow with reddish overtones, for example.

Tourmaline—Pink. For a period, pink was popular. In the early 1990s, prices of pink tourmaline rose in response (e.g., from approximately $85/ct to $100/ct for "fine" 3 ct stones). Subsequently, the prices showed little change.

Zoisite—Tanzanite. The roller coaster of tanzanite pricing resulted from many factors, including supply changes as mines closed and reopened, mining disasters, swings in consumer demand, and governmental controls. With all the fluctuations, however, prices in 1999 were only slightly less than they were at the beginning of the decade (e.g., $325/ct versus $360/ct for "fine" 3 ct stones).

Cultured Pearls—Strands. While prices increased during the first half of the decade, they leveled off quickly as the freshwater Chinese product started to appear. From 1995 to 1999, for example, the price of an 18-inch strand of white, $6^{1}\!/\!_{4}{}^{2}$–7 mm diameter, bead-nucleated cultured pearls averaged $500 for "good" quality, and $875 for "fine."

Cultured Pearls—South Sea and Tahitian. The following discussion is generalized for single, bead-nucleated, round to semi-round, 10–11 mm diameter cultured pearls with thick nacre, medium to high luster, and light blemishes. White South Sea cultured pearls held their value for most of the decade ($1,450 each for "fine" material from 1995 through 1999), although the January 2000 price was just over half that ($775). The prices for black Tahitian cultured pearls started to decline in 1998 (e.g., from $862 each for a "fine" 10–11 mm sample in 1997 to $475 each in the following year). Today, production is much greater and more sources are providing these large pearls, so prices are coming down.

Figure 10. This aerial view of the Argyle diamond mine in northern Australia, taken in February 2000, shows the enormous open pit and tailings piles. During the past decade, this mine has been the world's largest producer of diamonds by volume. Courtesy of Argyle Diamonds.

from 0.2 ct to over 1 ct (R. Kane, pers. comm., 2000).

The heat treatment of sapphires to improve their color and/or clarity remained a major industry in the 1990s. As noted above for rubies, premium prices for untreated blue sapphires are the norm (Federman, 1998). Most heat-treated high-quality blue and pink sapphire came from Sri Lanka and, more recently, Madagascar (Suwa, 1999). In particular, for the last couple of years the Ilakaka deposits have supplied enormous quantities of violet to purple sapphires that can be heat treated to produce pink material (Johnson et al., 1999b).

DIAMOND

All of the traditional diamond sources remained productive, led by the operations in southern and central Africa. The recovery of typically higher-quality diamonds from the seafloor off the coasts of Namibia and South Africa expanded greatly (Rombouts, 2000). In the northeastern part of South Africa, De Beers initiated modernized operations at their new Venetia mine in 1992. In addition, heightened diamond exploration activities during the '90s resulted in several new mining operations and prospects.

After the breakup of the former Soviet Union, a period of uncertainty began in the early 1990s with regard to the continued production of diamonds in Yakutia (now the Sakha Republic in the Russian Federation). Diminished financial resources hindered further development of the major mines in this remote region, especially given the potential need to transform open-pit operations to underground mining. However, progress was made in evaluating a new diamond field in the Arkhangelsk region northeast of St. Petersburg (Sobolev, 1999), although this area has not yet gone into production.

Very large quantities of mainly small brownish to yellow or near-colorless diamonds continued to be recovered from the Argyle mine in northern Australia (figure 10). This mine also produces rare pink-to-red diamonds, which have brought per-carat prices of US$100,000 or more at annual auctions ("Argyle Diamonds...," 1997). Toward the end of the decade, a decision was made to expand the area of the open pit over a two-year period to allow future access to additional ore reserves. However, concern about the number of diamonds that eventually can be recovered economically by open-pit mining has forced additional exploration in the mine area, as well as deliberations over the feasibility of developing underground operations.

One of the more exciting developments in recent years was the discovery of gem-quality diamonds in northern Canada and the subsequent identification of several potentially significant deposits over a wide area. Toward the end of the decade, diamond production began at the Ekati mine in the Northwest Territories (figure 11), with the probability that Canadian diamonds could supply more than 10% of world production by value early in the 21st century (Paget, 1999). Discovery of new diamond deposits has been aided by the use of high-technology exploration methods (thus far, similar methods have not achieved comparable success in locating new colored stone deposits; see Cook, 1997).

Distribution Changes and Branding. As the decade came to an end, the possibility of a "multi-channel" distribution system, with diamonds flowing from the mine to the consumer along several different routes that are not all controlled by De Beers, became a frequent topic of discussion (see, e.g., Sevdermish et al., 1998). The shift toward diamond branding at the end of the 1990s (e.g., efforts to "brand" the origin of diamonds from new deposits in Canada) is likely to increase consumer awareness of their geographic origin. Recently, De Beers acknowledged the reality of the multi-channel distribution system by announcing that rather than attempt to control world diamond supply, they would strive to be the supplier of choice for the industry (see, e.g., Behrmann and Block, 2000).

Country of Origin. For years, "country of origin" has played an important and sometimes controversial role in the marketing of some colored stones. At the end of the '90s, this phrase assumed new importance in the diamond industry, as some organizations and governments became concerned that profits from the sale of diamonds were being used to fund domestic conflicts in certain African countries. Angola, Sierra Leone, and the Democratic Republic of the Congo were singled out as areas of concern. This sparked a demand for documenting the source of such "conflict" diamonds to prevent them from entering the legitimate market. However, determining the geographic origin of diamonds is technically not feasible (Janse, 2000). More and more, efforts by producers and dealers alike are focused on preventing the purchase of diamonds from these areas, and providing documentation with each diamond that verifies its origin from a "nonconflict" source (see, e.g., http://www.gemprint.com; Heeger, 2000).

Figure 11. Canada became a new diamond source in the 1990s, with the opening of the Ekati mine in the Northwest Territories. All of these diamonds were faceted from Ekati mine rough; the marquise weighs 1.75 ct. Courtesy of Barker & Co.; photo © Jeff Scovil.

GARNET

Known sources of garnet—including localities in East Africa, India, and Sri Lanka—remained important. In the Ekaterinburg area of Russia, both the original locality (in the Babrovka River valley) and new deposits (at Karkodino) produced some fine-quality demantoid (figure 12). The first significant demantoid locality outside of Russia was discovered in Namibia in the mid-1990s, although the color of this new material is not as intense, and the stones lack the distinctive "horse-tail" inclusions that are characteristic of Russian demantoid.

Rhodolite and other garnets came from East Africa, while a new deposit of gem-quality grossularandradite was discovered in Mali at Diakon. New sources in Madagascar produced pyrope-spessartine (including color-change material) and tsavorite. Orange spessartine garnets continued to come from Namibia, Madagascar, and Zambia. Just as production from Namibia declined at the end of the 1990s, Nigeria provided larger and cleaner spessartines to

Figure 12. Fine demantoid garnet, such as the 4.49 ct stone shown here, was mined at both old and new localities in the Ural Mountains of Russia. The presence of "horsetail" inclusions (see inset; 1.46 ct) provides confirmation of Russian origin. Courtesy of Pala International; photos by Robert Weldon.

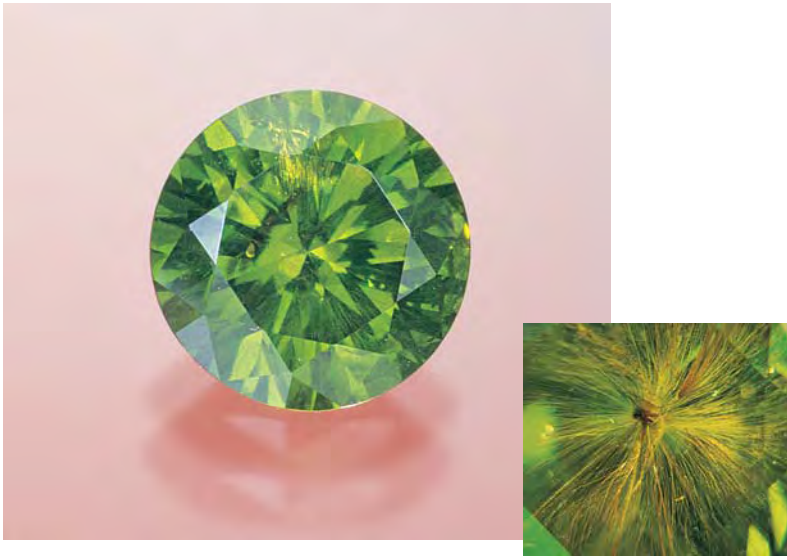

Figure 13. At the end of the decade, relatively large, clean spessartine garnets (such as the 12.97 ct stone shown here) came from a new deposit in southwestern Nigeria. Courtesy of Mayer & Watt; photo © Tino Hammid.

Figure 14. Large quantities of garnets—in several varieties—were recovered from the Tunduru area of Tanzania. The mines are worked by simple methods, as shown by this pit at Libafu. A portable wet-sieving machine is being used to concentrate the gem rough. Photo by Horst Krupp.

meet the market demand created by the Namibian material (see, e.g., Zang et al., 1999; figure 13). The Tunduru region of southern Tanzania has yielded large quantities of several different types of garnet (Henn and Milisenda, 1997; figure 14). A large new deposit in Lindi Province was the source of attractive tsavorite, which has helped replenish the diminishing production from traditional tsavorite localities in Kenya and northern Tanzania (H. Krupp, pers. comm., 1999).

JADE

Northern Myanmar continued to be the sole commercial source of high-quality green, lavender, and white jadeite, as well as other colors, with no shortage of supply in sight (Hughes et al., 2000; figure 15). New jadeite deposits are being exploited in Japan (Chihara, 1999), as well as in both Russia (the Polar Urals and in central Siberia) and southern Kazakhstan (N. Kuznetsov, pers. comm., 2000).

Nephrite deposits are located in the western portions of North America (especially British Columbia in Canada, as well as Alaska). Other deposits occur in Xiu Lan County, Liaoning Province, and other regions of China. As China continues its rapid economic development, it is likely that demand for both nephrite and jadeite jade will also increase in that marketplace.

OPAL

Australian localities in New South Wales, Queensland, and South Australia continued to be the major sources of most gem opal (figure 16). However, Mexico and Brazil were important producers of "fire" opal and white opal. Mexican fire opal experienced strong—but brief—popularity through marketing on television shopping networks. Subsequent problems with supply of this material, and its tendency for crazing, brought its popularity to an abrupt halt (P. and B. Flusser, pers. comm., 2000). Prices for black opal from Lightning Ridge, Australia, declined briefly due to the collapse of the Asian market (especially Japan), but subsequent demand from the strong U.S. market brought prices close to those in the early 1990s.

PERIDOT

The past decade witnessed the continued production of gem-quality olivine from the United States (Arizona), Myanmar, and China. However, the discovery of significant quantities of rich green peridot from Pakistan (figure 17), with exceptional clarity

and in large sizes (clean stones up to several hundred carats), created renewed enthusiasm for this gemstone (Frazier and Frazier, 1997). During the decade, commercial quantities of small pieces of peridot were recovered in Vietnam.

QUARTZ

The most significant amethyst-producing countries are first Brazil and then Uruguay, as well as Tanzania, Namibia, and Zambia. Although amethyst remains one of the most important commercial gems, the market for natural amethyst has been undermined by the widespread infiltration of synthetic amethyst. Much of this synthetic material can be separated from natural amethyst, but this often requires advanced gemological testing. As the cost of such testing often exceeds the value of the amethyst, widespread availability of the synthetic material has depressed the value of the natural gem.

Figure 15. Myanmar remains the world's only commercial source of fine jadeite. These exquisite fern leaf carvings show the saturated color and semi-transparency commonly associated with "Imperial" jadeite. The larger carving measures 57.11 × 28.87 × 3.59 mm; photo © Tino Hammid and Christie's Hong Kong.

Figure 16. Most gem opal, such as the black opal shown in this pendant, comes from Australia. The opal is set within carved aquamarine. Jewelry designed and created by Kreg Scully; photo © Jeff Scovil.

Figure 17. Commercial quantities of peridot became available in relatively large sizes from a new deposit in Pakistan. The faceted stone shown here weighs 172.53 ct, and the crystal is 6 cm tall. Courtesy of Pala International; photo © Jeff Scovil.

Figure 18. During the 1990s, fine amethyst, citrine, and ametrine (here, 21.88–66.91 ct) were recovered from the Anahí mine in Bolivia. Courtesy of Minerales y Metales del Oriente; photo by Robert Weldon.

Figure 19. Myanmar remained an important source of spinel such as this 3.2-cm-tall crystal and 7.38 ct oval brilliant. Courtesy of Barker & Co.; photo © Jeff Scovil.

Most citrine comes from Brazil; some is produced by the heat treatment of amethyst. Sporadic mining of ametrine (bicolored amethyst-citrine; figure 18) from Bolivia continued in the early and mid-1990s, but the quantity and quality of the material declined at the end of the decade (C. Marcusson, pers. comm., 2000).

SPINEL

Although increasing in consumer recognition and demand, spinel remains overshadowed in the marketplace by other colored gems such as ruby and pink sapphire. During the '90s, spinel was mined from traditional localities in Sri Lanka and Myanmar (figure 19), as well as by the reworking of historic sources such as in the Pamir Mountains of Tajikistan.

The most important new sources were Tunduru in southern Tanzania and Ilakaka in Madagascar. These have produced primarily smaller stones (0.5–1.5 ct) in many pastel colors. Spinel was also found in Vietnam as a byproduct of ruby and sapphire mining. Today, spinel is growing in popularity due to its attractive colors, high clarity, good durability, and the fact that it is not treated.

TANZANITE

Tanzania's Merelani area remains the only commercial source of tanzanite (figure 20). In the 1990s, tanzanite approached emerald, ruby, and sapphire in popularity in the U.S., but was in less demand elsewhere. Its single source, rich color, and availability in larger sizes made this gemstone a mainstay in some jewelry stores. Enormous fluctuations in production, and therefore also in price, eventually led to an oversupply on the market in the latter half of the decade. However, a disastrous mine accident in 1998 forced the Tanzanian government to impose restrictions on tanzanite mining. Subsequently, the reduced mining (also due to increased costs), the difficulty of recovering material from ever-greater depths, and the departure of miners to new gem-producing areas in southern Tanzania all combined to elevate the price of this unique gemstone close to levels attained in the early 1990s (Bertoldi, 1998; box A).

Merelani also has produced the rarer green zoisite, which is colored by chromium (Barot and Boehm, 1992). Recent discoveries of transparent pink and bicolored—pink and yellow—zoisite (Wentzell, 2000) may provide new insight into the geology of the Merelani area.

TOPAZ

As it has for many years, topaz came from Brazil (figure 21), Nigeria, Pakistan, Sri Lanka, and the Ural Mountains in Russia. Pink-to-orange "Imperial" topaz enjoyed a rise in price throughout the 1990s, due to controlled supply in Brazil and minimal production in Pakistan (Drucker, 1997; see also box A). One dramatic development was the decline in demand for irradiated blue topaz, for which much near-colorless topaz had been mined in the 1980s. Natural-color blue topaz was not commercially available during the '90s.

TOURMALINE

Because it occurs in large, often high-clarity crystals of almost every color, tourmaline remains one of the most popular colored stones. The past decade saw further mining at many Brazilian pegmatites, and increased production in many African countries including Nigeria, Zambia, Mozambique, Madagascar, Tanzania, and Kenya. Afghanistan continued to yield "pastel" pink and green stones, in addition to blue and bicolored material.

Irradiation of colorless to light pink tourmaline supplied significant amounts of deep pink to red material in the early to mid-1990s. During this decade, the bright blue, green, and purple tourmalines from Paraíba, Brazil (figure 22) reached record retail prices (one of the authors [WFL] sold a 4.49 ct blue stone for $16,000/ct [see photo on accompanying Gem Localities chart]) due to very limited availability and high demand (Drucker, 1997). In the mid-1990s, enormous quantities (tons) of bicolored and brownish pink material came from the Morro Redondo mine in Minas Gerais, Brazil. Blue-green tourmaline has been available from several deposits in Namibia. The last few years saw even larger quantities of attractive pink-to-red tourmaline from Nigeria (Schmetzer, 1999a; figure 23), but the deposits are now apparently exhausted (M. Diallo, pers. comm., 2000). The influx of this material onto the gem market also caused a significant decline in the price of rough red and pink tourmaline.

OTHER GEM MATERIALS AND NEW LOCALITIES

A number of other gem materials from various localities became available during the 1990s (see table 2; figure 24). Blue to green **apatite** from Madagascar was used as a substitute for the similarly colored tourmaline from Paraíba, Brazil. At the **Benitoite** Gem mine in California, an important extension of the historic deposit was found in 1997, and resulted in a small production of this material. The past decade witnessed the increasing availability of **charoite** from Siberia as an ornamental gem material, as well as the marketing of **chrome diopside** (Costanza, 1998a). Gem varieties of **feldspar** came

Figure 20. The world's only commercial source of tanzanite remained the Merelani area of Tanzania. The tanzanite in the diamond pendant weighs 22.60 ct, and the loose stones range from 4.54 to 22.26 ct. Courtesy of The Collector Fine Jewelry; photo © Harold & Erica Van Pelt.

Figure 21. Like jadeite and tanzanite, commercial deposits of Imperial topaz (here, set stone about 6 ct, and loose stone, 3.82 ct) are found in a single area of the world—in this case, near Ouro Prêto, Minas Gerais, Brazil. Jewelry courtesy of Suwa & Son; photo by Maha Tannous.

Figure 22. Brightly colored tourmaline from Paraíba, Brazil, commanded record prices in the second half of the 1990s due to its rarity and strong market demand. Courtesy of Karl Egon Wild; photo © Harold & Erica Van Pelt.

from various localities (such as India, Canada, and the U.S.), with the most popular being those that exhibited optical phenomena (i.e., moonstone, sunstone, peristerite, and labradorite). However, significant quantities of transparent sunstone also came onto the market. **Iolite** provided an inexpensive substitute for blue sapphire and tanzanite, and was mined in Canada, India, Sri Lanka, and Madagascar. **Maw sit sit**, from the famous jade mining region in Myanmar, became more available in the mid-1990s. Several hundred kilograms were recovered between 1995 and 1997, although supplies diminished toward the end of the decade. In the early 1990s, some of the world's finest **rhodochrosite** began being recovered from the Sweet Home mine near Alma, Colorado, through the application of innovative mining and exploration techniques (Lees, 1998).

Gem **scapolite** came from localities in Myanmar, Sri Lanka, Tanzania, Tajikistan, and China. **Sphene** was found in a number of countries, sometimes in important quantities from deposits in Brazil and Madagascar. In general, the availability and quality of **sugilite** from South Africa declined during the past decade, but small pieces of high-quality material were commonly inlaid together with other gem materials in jewelry (G. Stockton, pers. comm., 2000). Finally, **zircon** provided an inexpensive alternative to fancy-colored diamonds, and was produced in Australia, Southeast Asia, Sri Lanka, and East Africa. With the broader audiences reached by televised home shopping programs worldwide, as well as the Internet, many of these more unusual gem materials became familiar to—and embraced by—more consumers than ever before.

PEARLS

The 1990s may well be remembered as the most significant "pearl era" in modern history. Not only has production of cultured pearls increased dramatically, but the variety available has grown as well. Of particular note were "pink rosé" and white Chinese Akoya cultured pearls; numerous colors of Chinese freshwater cultured pearls; black Tahitian (French Polynesia), white South Sea (Australia), and "golden" cultured pearls from Indonesia and the Philippines; purple and green New Zealand and Pacific Coast cultured abalone mabes; and pink conch "pearls" from the Caribbean, and pink and orange *Melo* "pearls" from Southeast Asia. According to N. Paspaley (pers. comm., 2000), the cultured pearls being harvested today are among the finest ever produced in terms of quality, size, quantity, and possibly value. Never has more been understood about the biology, habitat, sources, and

Figure 23. At the end of the decade, large quantities of gem-quality pink-to-red tourmaline were found near Ogbomosho, Nigeria. These crystals and nodules of tourmaline were among the initial production; the cut stone weighs 15.0 ct. Courtesy of Pala International; photo by Robert Weldon.

Figure 24. A variety of less familiar gem materials were commercially produced during the 1990s. Shown here (from left to right) are: top—Malagasy sphene (29.17 ct), Burmese scapolite (59.95 ct), Indian iolite (19.74 ct); bottom—American benitoite (3.09 ct), Cambodian zircon (13.37 ct), Peruvian rhodochrosite (6.22 ct), and Malagasy apatite (4.07 ct). Courtesy of William Larson; photo © Harold & Erica Van Pelt.

growth and harvesting conditions of pearls worldwide (Akamatsu, 1999).

Compared to cultured pearls, natural pearls remained exceedingly rare, but demand by some consumers is driving a global effort to recover them (K. C. Bell, pers. comm., 2000). This will remain a small but compelling part of the pearl industry.

Cultured Pearls. During the 1990s, the Japanese experienced a sharp decline in the production of Akoya cultured pearls and consequently in their dominance of the pearl market, although they expanded their influence as cultivators by helping pearl growers in other regions. The reduced number of cultured pearls from Japan (Muller, 1998) was offset by the increased production and popularity of cultured pearls from French Polynesia and Australia (figure 25), as well as Indonesia (figure 26), the Philippines, and China. The 1990s also witnessed the reemergence of several areas (such as Myanmar) that had declined earlier in the 20th century, due to overharvesting and environmental degradation (see table 3). Pearl culturing also increased in Vietnam (Bosshart et al., 1993; "Vietnam produces Akoya," 1999).

M. Coeroli (pers. comm., 2000) reports that the widespread popularity of black cultured pearls from French Polynesia followed the steady growth of pearl production, which increased 1,323% over the decade: from 575 kg of *Pinctada margaritifera* cultured pearls in 1990 to nearly 8.2 metric tons in 1999. Yet during this period, the number of pearl-producing farms in French Polynesia dropped from a high of 2,500 early in the decade to 1,076 at the last official count in 1998. Several smaller farms disappeared, while others expanded their farming area. As a result, fewer farms are cultivating more Tahitian pearls.

One of the interesting new trends was the production and use of "keshi" pearls. Once applied only to extremely small Akoya natural pearls, today *keshi* (from the Japanese word for poppy seed) is the common name for a nonnucleated cultured pearl produced by the oyster when the nucleus is rejected. Common byproducts of Australian and French Polynesian pearling operations, these baroque-shaped cultured pearls can reach up to 7–8 mm. By the mid-1990s, strands of such "keshis" were as popular as strands of round and semi-round cultured pearls (Federman, 1997), and their demand continued through the end of the decade (F. Mastoloni, pers. comm., 1999; M. Goebel, pers. comm., 2000).

According to N. Paspaley (pers. comm., 2000), successful pearl-farming techniques for South Sea pearl oysters (*Pinctada maxima*) were not developed until the 1980s. Since growth and harvesting can take up to eight years, noticeable achievements in production were not realized until the 1990s. Also during the '90s, new technology for the artificial propagation of the pearl oyster contributed to the increased production. Today, the Indonesian and Philippine pearl-culturing industries are completely dependent on hatcheries to supply the pearl oysters; only Australia and Myanmar have commercially important beds of natural *P. maxima* (N. Paspaley,

Figure 25. French Polynesia and Australia were the principal sources of black Tahitian and white South Sea cultured pearls, respectively. The cultured pearls in the necklaces shown here range from 11.69 to 16.21 mm (Tahitian) and 12.80 to 17.69 mm (South Sea). Photo © Tino Hammid and Christie's Hong Kong.

pers. comm., 2000; Themelis, 2000). Note that unlike other pearl oysters that easily can be bred in captivity, even artificially propagated *P. maxima* will grow to maturity only in their natural environment. Any future increase in pearl production from this region will largely be determined by the ability of pearl farmers to control pollution so they have favorable environmental conditions for the successful cultivation of hatchery-produced oysters.

Natural abalone pearls, still very rare, continued to be found sporadically in many localities (see table 3; figure 27). For the first time, successful production of cultured abalone mabes and a few whole cultured abalone pearls was realized in the 1990s (Fankboner, 1994). These came from abalone growers on the Pacific Coast of North America and in New Zealand. Mabes are more easily produced, and New Zealand cultured abalone mabes have appeared in commercial quantities since 1997 (Wentzell, 1998).

For freshwater cultured pearls, China clearly dominated the decade. Production of up to 1,200 metric tons is estimated for the year 2000 alone (A. Muller, pers. comm., 2000). Improved culturing techniques—using mantle-tissue nuclei—permitted the growth of large quantities of very attractive pearls, in large sizes, with remarkable roundness, and in a variety of uniform, natural-looking colors (figure 28). In years to come, China may also have a major effect on the market for bead-nucleated freshwater cultured pearls (Tao, 2000) if they succeed in expanding the availability of less-expensive round cultured pearls in sizes over 10 mm.

Pearl-culturing efforts in the southeastern U.S., led initially by John Latendresse of American Pearl Co. and later followed by James Peach of U.S. Pearl Co., produced a steady supply of freshwater cultured pearls throughout the decade, in creative shapes ranging from crosses to hearts and tabular forms (G. Latendresse, pers. comm., 2000). Also notable is the widespread incorporation of American shell-bead nuclei from the freshwater *Unio* mollusks for pearl culturing in most species. The U.S. exports to Japan an estimated $50 million annually in shells for making bead nuclei (Mayell, 1998). While today

Figure 26. At the Togian Islands in central Sulawesi, Indonesia, a pearl-oyster technician places a bead nucleus in the optimal location with the help of strong fiber-optic light. Photo by Andy Muller.

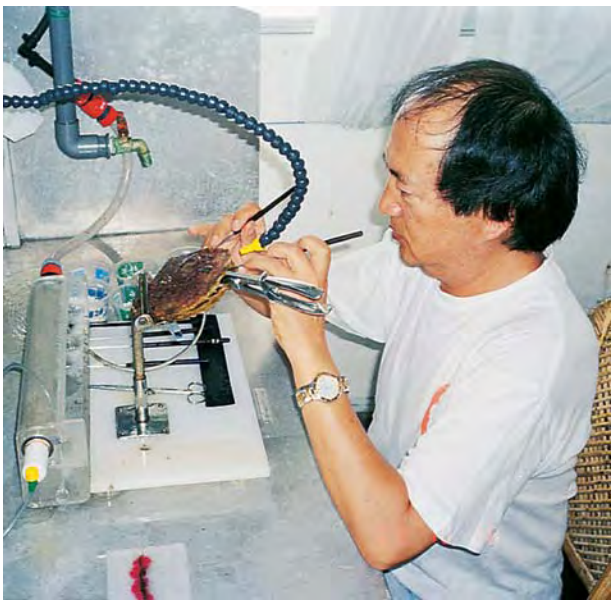

Figure 27. Because natural abalone pearls are so rare, considerable effort has been made to produce cultured abalone pearls. One of the success stories of the '90s was the introduction of commercial quantities of cultured abalone mabe pearls from New Zealand. The largest (natural) abalone pearl here weighs 77.75 ct. Courtesy of Tish and Wes Rankin, Pacific Coast Pearls; photo © Harold & Erica Van Pelt.

growers are testing other materials, most pearl culturers continue to use the *Unio* bead.

Unfortunately, American freshwater mollusks have become threatened by environmental problems caused by dam construction, silt from agriculture, water pollution, mining, industrial waste, and especially the introduction of an exotic bivalve—the zebra mussel (*Dreissens polymorpha*). The zebra mussel has no natural enemies, and is capable of outcompeting the roughly 300 species of pearl-producing freshwater mollusks remaining in U.S. rivers, streams, and lakes. Biologists estimate that 30% of the U.S. pearly species are already extinct, and 65% are endangered (Helfich et al., 1997).

Research and development in pearl-culturing technology led to significant discoveries during the past decade. In 1994, an international pearl conference and exposition was held in Hawaii that brought together—for the first time—pearl scientists, aquaculturists, government leaders, and pearl dealers (Sims and Fassler, 1994). Scientists reported the use of antibiotics and steroids to improve culturing success. Aquaculturists reviewed efforts to grow spat and introduce pearl-producing mollusks in areas (such as Hawaii) that had been overharvested at the turn of the century. Small operators in India were exploring freshwater bodies for pearl culturing. Speakers also discussed prospects for pearl-culturing industries in Mexico and Colombia. Interest in technical developments continues, and ongoing research is reported in journals such as *Aquaculture* and *Pearl Oyster Bulletin*.

Regional pearl associations emerged following the conference, and joined efforts by the World Pearl Congress to distribute newsletters via the Internet and promote pearls to the jeweler, as well as directly to the consumer, through the popular press. This, combined with exposure through movies and television programs, brought pearl fashion to the consumer internationally (M. Coeroli, pers. comm., 2000).

Calcareous Concretions. There was renewed interest in calcareous concretions, such as conch "pearls" from the Caribbean *Strombus gigas* and the new *Melo* "pearls" from Southeast Asia. In vogue at the turn of the 19th century, conch "pearls" regained popularity once their availability increased. They are recovered primarily from waters near the Bahamas, Bermuda, and Cuba (Fritsch and Misiorowski, 1987), as well as the southeastern U.S. (Shirai, 1994).

Early in the 1990s, small quantities of pink and orange calcareous concretions began to be reported

Figure 28. Toward the end of the decade, large, round cultured pearls from China (here, 9–11 mm in diameter) were available in significant quantities and a variety of colors. Courtesy of Rafco; photo by Robert Weldon.

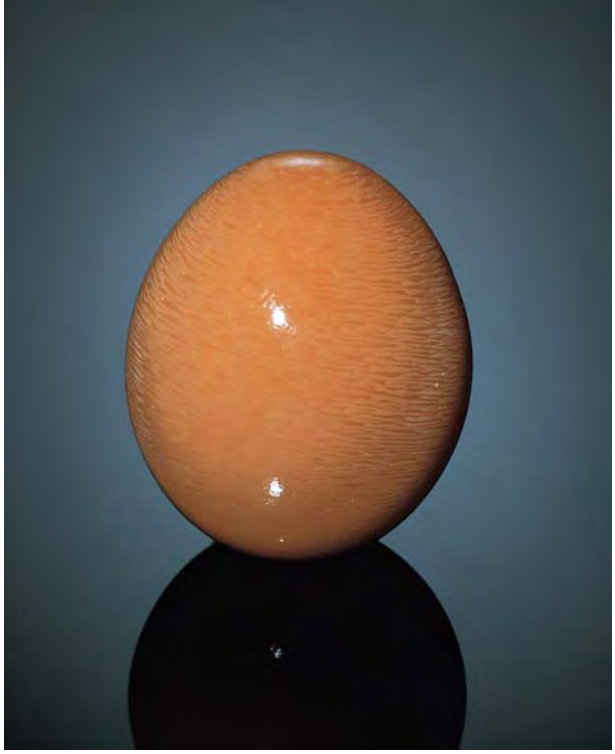

Figure 28. Calcareous concretions from the Melo *gastropod, which first appeared in the marketplace during the '90s, fetched record prices by the end of the decade. This 23.0 × 19.35 mm* Melo *"pearl" sold for $488,800 at the November 1999 Christie's jewelry auction in Hong Kong.*

from the *Melo* genus of the Bailer volutes, a spiral gastropod. They are harvested primarily from Southeast Asian waters, especially off the coasts of Vietnam (Jobbins, 1992; Scarratt, 1992; Zucker, 1999) and Myanmar (K. Scarratt, pers. comm., 2000). *Melo* "pearls" have also been reported from the South China Sea, India, Indonesia, and Malaysia (Shirai, 1994; K. Scarratt, pers. comm., 2000). At the November 1999 Christie's jewelry auction in Hong Kong, a 23.0 × 19.35 mm *Melo* "pearl" sold for US$488,800 (figure 28).

CONCLUSION AND FUTURE PROSPECTS

While for many gem materials most of the countries now considered important producers were identified by the 1970s, the discovery of new deposits within these countries, and even deposits in newly identified source countries, continued throughout the 1990s. Tanzania and Madagascar appeared to have the largest number of new gem deposits (see, e.g., Pezzotta, 1999). Vietnam (ruby and sapphire) and Nigeria (spessartine and tourmaline) also emerged as commercially important gem producers.

The past decade witnessed some exciting developments for the gem and jewelry industry. Diamonds were discovered in Canada, where no commercial diamond deposits had been known. The increased demand for colored stones, along with a better understanding of gem occurrences, has fueled greater exploration and recovery. Cultured pearls, once dominated by the round, white Japanese Akoyas, are now produced in an astonishing array of colors, qualities, and shapes from multiple geographic sources.

Sociopolitical conditions continued to play an important role in the 1990s. Predictions made by Shigley et al. (1990) for significant opening of Afghanistan, the former Soviet Union, and China have not yet come to pass due to the lack of infrastructure and capitalization. The discovery of major ruby deposits at Mong Hsu increased Myanmar's importance as a gem producer (Kammerling et al., 1994b), but military restrictions limit access to the area. Yet the greater freedom of trade in Vietnam has undoubtedly contributed to the discovery and exploitation of gem deposits there, especially ruby and sapphire.

Environmental concerns continued to influence both gem-mining and pearl-culturing activities. South Africa's Venetia mine, Australia's Argyle mine, and Canada's Ekati mine were each constructed to recover diamonds with state-of-the-art processing plants and extensive environmental controls. By contrast, at Canada's Diavik mine, a temporary denial of a crucial land permit for environmental reasons in 1999 resulted in the delay of mine development (Schuster, 2000). In the Ambondromifehy area of northern Madagascar, all sapphire mining was halted for several months of 1998 due to illegal digging in the Ankarana Special Reserve (Lurie, 1998). For cultured pearls, the greatest concern is water quality. At Ago Bay in Japan, some have blamed pollution from formalin—a liquid formaldehyde that the Japanese used to treat parasites in blowfish (Costanza, 1998b)—for the dramatic decline in the production of Akoya cultured pearls. Throughout the South Seas, instances of industrial development and destructive fishing practices threatened pearl production (D. Fiske, pers. comm., 2000).

Looking into the next decade, we predict the continued expansion of gem production in East Africa, Madagascar, and Southeast Asia, while Brazil and Myanmar remain important sources. New gems as well as new gem localities will undoubtedly be discovered, especially as remote areas become more accessible and technology advances.

TABLE 1. Gem localities of the 1990s for major gemstones.[a]

Gem material/locality	Reference
BERYL—Emerald	
◆ Africa	
Madagascar	
Fianarantsoa—**Mananjary**: *Ankadilalana, Infanadiana, Irondro, Morafeno* (7)	Schwarz and Henn (1992), Thomas (1993), Schwarz (1994)
Toliara—Ianapera (4)	Marchand (1995)
Mozambique	Malango and Taupitz (1996)
Nampula—Alto Ligonha (1)	Milisenda et al. (2000)
Zambezia—Morroa: *Maria* (6)	Thomas (1994)
Nigeria	
Kaduna—Gwantu	Kammerling et al. (1995g), Schwarz et al. (1996a)
Plateau—Janta, Rafin Gabas Hills, Sha Kaleri	Schwarz et al. (1996a)
Plateau—Jos	Lind et al. (1986)
Plateau—Nassarawan Eggon: *Kwafam Gwari*	Kammerling et al. (1995g), Schwarz et al. (1996a)
Tanzania	
Arusha—Lake Manyara: *Mayoka (Manyara)* (1)	Dirlam et al. (1992), Keller (1992)
Arusha—Ngorongoro: *Manghola* (13)	Suleman et al. (1994)
Rukwa—Sumbawanga (10)	Dirlam et al. (1992)
Zambia	
Copperbelt—**Kafubu**: *Chama, Dabwisa, Fibolele, Fwaya-Fwaya, Kamakanga, Kanchule, Libwente, Miku, Mitondo, Nkabashita, Pirala* (4)	Milisenda et al. (1999)
Zimbabwe	Kanis et al. (1991)
Matabelleland South—**Sandawana**: *Aeres, Machingwe, Orpheus, Zeus* (6); Zvishavane: *Mberengwa* (4)	Zwaan et al. (1997), Zwaan and Touret (2000)
Victoria—Bikita: *Chikwanda* (5); Masvingo: *Mayfield, Novello* (1)	
◆ Asia	
Afghanistan	
Parwan—**Panjshir Valley**: *Bakhi, Butak, Buzmal, Darun, Khenj, Mikeni* (5)	Bowersox et al. (1991), Bowersox and Chamberlin (1995)
India	
Andhra Pradesh—Srikakulam: *Kurupam* (30)	Panjikar (1995a)
Orissa—Balangir: *Kantabanji* (10)	Choudhuri and Gurachary (1993)
Rajasthan—Udaipur: *Kaliguman* (16)	S. Fernandes (pers. comm., 1999)
Tamil Nadu—Salem: *Sankari Taluka* (17)	Panjikar et al. (1997)
Pakistan	
Northwest Frontier—Mohmand: *Bucha* (5); **Swat River Valley**: *Charbagh, Gujar Killi, Makhad, Mingora, Shamozai* (4)	Arif et al. (1996), Aboosally (1999)
Russia	
Middle Ural Mountains—Malysheva, Takovaya: *Izumrudnie Kopi*	Schmetzer et al. (1991), Laskovenkov and Zhernakov (1995), Emlin (1996), Burlakov et al. (1997), Spiridonov (1998)
◆ Australia	Schwarz (1991a)
New South Wales—New England Range: *Emmaville, Torrington* (19)	Schmetzer (1994), Webb and Sutherland (1998)
Queensland—Mount Surprise (20)	Wilson (1995)
Western Australia—Pilbara: *McPhees Patch, Pilgangoora, Wodgina* (21); Poona: *Menzies, Poona* (2)	
◆ North America	
United States	
North Carolina—Mitchell: *Hiddenite*	Sinkankas (1997), Stone (1999)
◆ South America	
Brazil	Giuliani et al. (1990b, 1997)
Bahia—Anagé: *Açude, Juca, Lagoa Funda, Lagoinha, Piabanha, Pombas, Sossêgo* (14); Brumado (30); Campo Formoso: *Bica, Bode, Braúlio, Cabra, Formiga, Gavião, Lagarto, Marota, Trecho Novo, Trecho Velho* (5); **Carnaíba-Socotó**: *Arrozal, Carnaiba, Catuaba, Mundé, Socotó, Veio do Sebo* (5)	Schwarz et al. (1990), Couto (2000)
Ceará—Solonópole: *Coqui* (32); Tauá: *Boa Esperança* (31)	
Goiás—Itaberaí (35); Pirenópolis (33); **Porangatu**: *Mara Rosa, Pela Ema, Porangatu, Santa Terezinha* (34)	Pulz et al. (1998)
Minas Gerais—**Itabira**: *Belmont* (3); **Nova Era**: *Capoeirana* (3)	de Souza et al. (1992)
Tocantins—Araguaia: *Monte Santo* (41)	César-Mendes and Ferreira (1998), Johnson and Koivula (1998d)
Colombia	Giuliani et al. (1990a, 1995, 2000), Bosshart (1991), Schwarz (1991b, 1992), Branquet et al. (1999)
Boyacá—**Chivor**: *Buena Vista, Chivor, Las Vegas de San Juan (Gachalá), Mundo Nuevo, Somondoco* (3)	
Boyacá—**Muzo**: *Cosquez, El Chule, La Pita, Muzo, Peñas Blancas, Polveros, Santa Barbara, Tequendama* (1)	Ottaway et al. (1994), Johnson and Koivula (1996b), Johnson et al. (2000a)
BERYL—Aquamarine/ Heliodor/Morganite	
◆ Africa	
Kenya	
Eastern—Embu (2)	Barot et al. (1995)
Rift Valley—Baragoi: *Nachola* (3)	Keller (1992)
Madagascar	Henn et al. (1999b)
Antananarivo—Ankazobe (1); Betafo: *Anjanabonoina, Mahaiza, Tongafeno* (2); Soavinandriana (11)	Pezzotta (1999)
Antananarivo—Sahatany Valley: *Ibity, Manjaka, Tsilaizina* (3)	Lefevre and Thomas (1997), Pezzotta (1999)
Antsiranana—Andapa (19)	
Fianarantsoa—Ambositra (16), Fianarantsoa (51), Lac Itahy (18), Vondrozo (20)	Pezzotta (1999)
Mahajanga—Berere (5), Boriziny (40), Tsarantanana (6)	Pezzotta (1999)
Toamasina—Amboasary (14)	
Toliara—Tolanaro (21)	
Malawi	
Northern—Mzimba (1)	Milisenda et al. (2000)
Mozambique	Correia Neves (1987), Malango and Taupitz (1996)
Nampula—**Alto Ligonha**: *Macula* (1), *Muiane* (1); Monapo (2)	
Zambezia—Mocuba (3)	
Namibia	
Karibib—Usakos: *Spitzkoppe* (2)	Cairncross et al. (1998)
Nigeria	
Kaduna—Gwantu	Kammerling et al. (1995g)
Plateau—Jos	Lind et al. (1986)
Plateau—Nassarawan Eggon: *Sabon Wana, Tundun Delli*	Kammerling et al. (1995g), Schwarz et al. (1996a)
Plateau—Rafin Gabas Hills	Kanis and Harding (1990)
Plateau—Janta, Sha Kaleri	Schwarz et al. (1996a)
Tanzania	
Arusha—Loliondo (8), Longido (9)	Dirlam et al. (1992)
Dodoma—Kondoa (41)	A. Suleman (pers. comm., 1999)
Morogoro—Mvuha (30)	Dirlam et al. (1992)
Rukwa—Sumbawanga (10)	Dirlam et al. (1992)

[a] *This chart includes key producing localities of the decade, with references to publications in the contemporary literature. The country name is followed by the province/state/region, then the district, and finally the mine/deposit/occurrence name (in italics). Districts shown in bold were particularly important gem producers in the 1990s. Numbers in parentheses refer to locations plotted on the regional maps. Some countries are not shown on these maps, and therefore do not have any numbers indicated.*

Aquamarine-bearing pegmatites in Brazil have yielded some attractive crystals. This 12.6-cm-long aquamarine crystal, from the Teófilo Otoni region of Minas Gerais, shows both gemmy and opaque portions. Courtesy of Pala International; photo by Jeff Scovil.

Gem material/locality	Reference
Ruvuma—Nyamtumbo (42)	A. Suleman (pers. comm., 1999)
Singida—Singida (11)	Keller (1992)
Zambia	Milisenda et al. (2000)
Central—Kabwe: *Jagoda, Muchinga* (13)	
Eastern—Lukusuzi (6)	M. Sarosi (pers. comm., 1999)
Eastern—Lundazi: *Chama, Fwaya-Fwaya, Pela (Kapirinkesa)* (2)	Mambwe and Sikatali (1994)
Northern—Luangwa Valley (3)	
Western—Namwala: *Mumbwa, Namwala* (14)	
Zimbabwe	
Mashonaland North—Mwami–Karoi (2)	Shmakin and Wedepohl (1999), Milisenda et al. (2000)
◆ Asia	
Afghanistan	Bowersox and Chamberlin (1995)
Konar—Dhray-Pech, Gur Salak, Paprowk (2)	
Laghman—Mawi, Nilaw-Kolum (3)	
Nangarhar—Darre Nur (4)	
China	
Yunnan—Yuan Jiang: *Ailao Mountains*	More new finds... (1996)
India	
Gujarat—Panch Mahal: *Palikhanda* (11)	Panjikar (1996)
Jammu and Kashmir—Kargil: *Dangel, Padam* (12)	Panjikar (1994a)
Karnataka—Hassan: *Dodkadanur* (34); Mysore: *Melkote* (33)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Ambikapur: *Newatola, Sapha* (31); Bastar: *Bhopalpatnam* (51); Raigarh: *Belghutri, Ginabahar* (38)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Deobhog (19)	Jha et al. (1993)
Orissa—Balangir: *Ghuchepara, Saraibahal* (10)	Choudhuri and Gurachary (1993), Panjikar (1995b)
Orissa—Kalahandi: *Banjipadar, Sargiguda* (53)	S. Fernandes (pers. comm., 1999)
Orissa—Phulabani (13)	Current mining report... (1998)
Orissa—Sambalpur: *Bagdhapa, Charbati, Meghpal* (5)	Das (1993), Current mining report... (1998)
Rajasthan—Ajmer (14), Tonk (15), Udaipur (16)	Panjikar (1994b), Current mining report... (1998)
Tamil Nadu—Dindigul Anna: *Ayyalur, Sullerumbhu* (8)	S. Fernandes (pers. comm., 1999)
Tamil Nadu—Karur (54)	Boehm (2000)
Tamil Nadu—Salem (17)	J. Panjikar (pers. comm., 1999)
Kazakhastan	Smith and Smith (1995)
Qaraghandy—Balqash: *Kounradskiy*	
Qaraghandy—Taldyqorghan: *Aqshatau*	Spiridonov (1998)
Myanmar	
Mandalay—Mogok: *Ka-Baing, Sakangyi* (1)	Kammerling et al. (1994b)
Sagaing—Thazi: *Ye-bu* (7)	U Hlaing (pers. comm., 1999)
Nepal	Niedermayr (1992)
Bagmati—Kakani (1)	
Gandaki—Lamjung (2)	
Kosi—Ikuh Khola (3), Sankhuwasabha (4), Topke Gola (4)	
Mechi—Taplejung (4)	
Seti—Khaptad (5)	
Pakistan	
Northern Areas—Baltistan: *Dassu, Gone, Teston* (3)	Blauwet et al. (1997)
Northern Areas—Gilgit: *Buleche, Haramosh, Shengus* (2)	Blauwet et al. (1997)
Northwest Frontier—Chitral: *Garam Chashma* (1)	Khan (1986)
Russia	
Chita—Urchugan River	Spiridonov (1998)
Ekaterinburg—Asbest: *Shaytanka*	Emlin (1996), Spiridonov (1998)
Middle Ural Mountains—Mursinka–Adui: *Alabashka, Mursinka, Shaitanka, Yushakova*	Smith and Smith (1995), Emlin (1996)
Transbaikalia—Borzja: *Sherlova Gora*	Spiridonov (1998)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18); Kegalla: *Avissawella* (9); Nuwara Eliya: *Kuruwitenna* (13), *Nawalapitiya* (29); Polonnaruwa: *Elahera* (8)	
Southern—Hambantota: *Lunugamwehera* (30); Kalutara: *Horana* (34); Matara: *Akuressa, Morawaka* (4); Monaragala: *Embilipitiya* (19), *Monaragala* (6), *Okkampitiya* (5); Ratnapura: *Balangoda* (2), *Kuruwita* (1), *Rakwana* (3), *Ratnapura* (1)	
Tajikistan	
Turkistan—Pamir Mountains: *Rangkul, near Murgab*	Skrigitil (1996), Spiridonov (1998)
Ukraine	Evseev (1994a)
Volyns'ka—Vladimir-Volnskiy	Koshil et al. (1991), Touret (1992)
Zhytomyr—**Zhytomyr**: *Volodarsk-Volnskiy*	Koivula et al. (1993b)
Vietnam	
Thanh Hoa—Thuong Xuan (1)	Ngu and Ngoc (1986)
◆ North America	
Canada	
British Columbia—Bennett: *Mount Foster*; McDame: *Horseshoe Ranch*; Passmore: *B-Q Claims*	Wilson (1999)
United States	Jacobsen (1993), Sinkankas (1997)
California—Pala: *Elizabeth R, White Queen*	
Colorado—Chaffee: *Mount Antero*	
Idaho—Sawtooth Mountains	
Maine—Oxford-Sagadahoc: *Bennett Quarry, Oxford,*	

Gem material/locality	Reference
Stoneham, Topsham	
New Hampshire—Grafton: *Grafton*; Sullivan-Cheshire: *Keene*	
◆ South America	
Brazil	Cassedanne and Alves (1991, 1992)
Bahia—Alcobaça: *Juerana* (20); Itambé: *Morro da Gloria, Paraíso* (24); Itanhém: *Jaqueto* (20); Macarani: *Lajedinho* (13); Maiquinique: *Jagarauna* (13); Vitória de Conquista: *Cercadinho* (14)	Cassedanne and Alves (1994), Couto (2000)
Ceará—Icó: *Serrote* (32)	Cassedanne and Alves (1994)
Espírito Santo—Baixo Guandu: *Santa Cruz (Itapina)* (16); Castelo: *Forno Grande* (15); Itaguaçu: *Bôa Vista* (16); Mimoso do Sul: *Concórdia* (15); Muqui: *São Domingos* (15); Pancas (16)	Cassedanne and Alves (1994)
Minas Gerais—**Jequitinhonha River Valley**: *Coronel Murta*, *Frade, Ilha Alegre, Laranjeiras, Manuel Silva* (18); Marambaia: *Coroa de Ouro, Galvão, Mucaia, Papamel* (22); **Mucuri River Valley**: *Marta Rocha* (22); Padre Paraíso (22);Pedra Azul: *Fortaleza, Medina, Pavão* (18); Salinas River Valley: *Bananal*, *Salinas* (18); Santa Cruz River Valley: *Três Barras, Urubu* (22); **Santa Maria de Itabira**: *Barro Prêto, Funil, Jatobá, Ponte da Raiz, Ribeirão Passa Bem, Tatu* (3); Sapucaia do Norte: *Sapucaia* (8)	Cassedanne and Alves (1994)
Paraíba—Frei Martinho: *Alto Quixaba* (24); Pedra Lavrada: *Alto das Flechas* (10)	R. Wegner and O. Moura (pers. comm., 2000)
Paraíba—Taperoá: *Pitombeira* (21)	Cassedanne and Alves (1994)
Rio Grande do Norte—Parelhas: *Carnaubinha* (10)	R. Wegner and O. Moura (pers. comm., 2000)
Rio Grande do Norte—Santa Cruz: *Gameleira* (10); *Tenente Ananias* (36)	Cassedanne and Alves (1994)
CHRYSOBERYL (Including cat's-eye)	
◆ Africa	
Madagascar	Henn et al. (1999b)
Antananarivo—Ankazobe (1)	
Fianarantsoa—Ambositra (16)	
Fianarantsoa—**Ilakaka–Sakaraha** (23)	Hänni (1999)
Toamasina—Ambatondrazaka (22)	Pezzotta (1999)
Tanzania	
Arusha—Lake Manyara: *Mayoka (Manyara)* (1)	Dirlam et al. (1992)
Ruvuma—**Tunduru**: *Muhuwesi River* (2)	Milisenda et al. (1997)
◆ Asia	
India	
Andhra Pradesh—Araku Valley (42); Khaman (1)	Current mining report... (1998)
Andhra Pradesh—Nellore (18)	J. Panjikar (pers. comm., 1999)
Andhra Pradesh—**Vishakhapatnam**: *Narsipatnam* (3)	Panjikar and Ramchrandran (1997), Current mining report... (1998), Kasipathi et al. (1999)
Kerala—Trivandrum (9)	Menon et al. (1994), Rajesh-Chandran et al. (1996)
Madhya Pradesh—Deobhog: *Jagdalpur, Mainpur* (19)	Jha et al. (1993)
Orissa—**Balangir**: *Jerapani, Sarapali* (10)	Choudhuri and Gurachary (1993), Panjikar and Ramchrandran (1997)
Orissa—Boudh: *Boudh, Ramgarh* (13); Kalahandi: *Sirjapali, Tundla* (53); Phulabani: *Belghar* (13); Rayagada: *Hatamuniguda, Karlagati, Paikdakul-gudu* (30)	S. Fernandes (pers. comm., 1999)
Orissa—Ranigurha: *Dakalguda* (57)	Panjikar and Ramchrandran (1997)
Orissa—Sinapali (21)	Viswanatha (1982)
Tamil Nadu—Dindigul–Anna: *Dharapuram* (8); Karur (54); Madurai: *Oddanchattram* (7)	Viswanatha (1982), Current mining report... (1998)
Tamil Nadu—Kanyakumari–Tirunelveli: *Arumanai, Karakonam, Midolam, Polukal* (6)	S. Fernandes (pers. comm., 1999)
Myanmar	
Mandalay—Mogok (1)	Hughes (1997)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18); Kegalla: *Avissawella* (9); Nuwara Eliya: *Kuruwitenna* (13); Polonnaruwa: *Elahera, Kaluganga Valley, Laggola* (8)	
Southern—Galle: *Galle* (12); Hambontota: *Ambalantota* (11); Kalutara: *Alutgama* (10), *Horana* (34); Matara: *Akuressa* (4), *Deniyaya* (31); Monaragala: *Embilipitiya* (19); **Ratnapura**: *Balangoda* (2), *Pelmadulla* (1), *Rakwana* (3), *Ratnapura* (1), *Walawe* (1)	
◆ Australia	
Western Australia—Dowerin (13)	Bevan and Downes (1997)
◆ South America	
Brazil	Cassedanne and Roditi (1993)
Espírito Santo—Colatina: *Córrego Alegre* (16)	
Minas Gerais—Malacacheta: *Córrego do Fogo* (19); Padre Paraíso: *Americana River Valley, Santana River Valley* (22)	
CHRYSOBERYL—Alexandrite	
◆ Africa	
Madagascar	
Fianarantsoa—Ambodibakoly: *Kianjavato* (24)	D. Grondin (pers. comm., 1996)
Fianarantsoa—**Ilakaka–Sakaraha** (23)	Hänni (1999), Henn et al. (1999b)
Tanzania	
Arusha—Lake Manyara: *Mayoka (Manyara)* (1)	Dirlam et al. (1992), Keller (1992), Barot et al. (1995)
Lindi—Liwale, Nguhumahinga River (43)	H. Krupp (pers. comm., 1999)
Mtwara—Masasi: *Nachingwea* (20)	A. Suleman (pers. comm., 1999)
Ruvuma—**Tunduru**: *Muhuwesi River* (2)	Milisenda et al. (1997), Burford (1998)
◆ Asia	
India	
Andhra Pradesh—Araku Valley (42), Khaman (1), Krishna River (2)	Current mining report... (1998)
Andhra Pradesh—Vishakhapatnam: *Narsipatnam* (3)	Panjikar and Ramchrandran (1997), Kasipathi et al. (1999)
Kerala—Travancore: *Arvikkara* (69)	Viswanatha (1982), Menon et al. (1994), Current mining report... (1998)
Madhya Pradesh—Deobhog: *Latapara, Mainpur, Matrapara, Sendmuda* (19) (1997)	Jha et al. (1993), Panjikar and Ramchrandran
Orissa—Balangir: *Sarapali* (10)	Current mining report... (1998)
Orissa—Kalahandi: *Siminiguda* (53); Subarnapur: *Sonepur* (10)	S. Fernandes (pers.comm., 1999)
Orissa—Ranigurha: *Dakalguda* (57), Sambalpur: *Meghpal Ranchipada* (5)	Patnaik and Nayak (1993)
Tamil Nadu—Dindigul–Anna: *Dharapuram* (8); Kangayam(54); Kanyakumari (6); Karur (54); Madurai: *Oddanchattram* (7); Palni (55)	Current mining report...(1998), Viswanatha (1982)
Russia	
Middle Ural Mountains—Asbest, Malysheva: *Izumrudnie Kopi*	Evseev (1993b), Smith and Smith (1995), Emlin (1996), Burlakov et al. (1997)
Sri Lanka	
Southern—Matara: *Akuressa*, *Morawaka* (4); Ratnapura: *Eheliyagoda* (25), *Pelmadulla* (1), *Rakwana* (3), *Ratnapura* (1)	Milisenda and Henn (1999)
◆ South America	
Brazil	
Bahia—Carnaíba: *Carnaíba* (5)	Cassedanne and Roditi (1993)
Goiás—Porangatu: *Pela Ema* (34)	Pers. knowl. of author (GB)
Goiás—Uruaçú (17)	N. Haralyi (pers. comm., 1998)
Minas Gerais—**Antônio Dias**, Hematita, Santa Maria de Itabira (3)	Cassedanne and Roditi (1993)
Minas Gerais—Malacacheta: *Córrego do Fogo, Setubal River, Soturno River* (19)	Cassedanne and Roditi (1993)
CORUNDUM—Ruby	
◆ Africa	
Kenya	
Central—Thika: Chania River (6)	Keller (1992)

Gem material/locality	Reference
Coast—**Mangari**: *John Saul* (20)	Keller (1992), Emmett (1999b), Mercier et al. (1999a)
Coast—Taita Hills (7)	Barot et al. (1995)
Eastern—Kitui: *Taawajah* (8)	Barot and Harding (1994)
Rift Valley—West Pokot (16)	Keller (1992)
Madagascar	
Antananarivo—Antanifotsy (10)	Henn et al. (1999b), Pezzotta (1999)
Toliara—Ejeda (9), Gogogogo (8)	Henn et al. (1999b)
Toliara—Tolanaro: *Fotadrevo-Vohibory* (21)	Johnson and Koivula (1996f), Mercier et al. (1999b)
Malawi	
Southern—Chimwadzulu Hill (2)	Henn et al. (1990a), Emmett (2000)
Tanzania	
Arusha—Babati (23), Lake Manyara (1), Lelatema (3)	Dirlam et al. (1992)
Arusha—Longido: *Elkunulesilali, Lomwinyi, Mdarara, Olgira Hills* (9)	Dirlam et al. (1992), Keller (1992)
Arusha—Lossogonoi Hill (24)	Keller (1992), Suleman et al. (1994)
Arusha—Ngorongoro (13)	Bank and Henn (1988)
Dodoma—Kilosa (6), Mpwapwa (5)	Dirlam et al. (1992)
Kilimanjaro—Same (17)	Dirlam et al. (1992)
Lindi	
Morogoro—Gairo (25)	Keller (1992)
Morogoro—Luande (26), Mwarazi (29)	Suleman et al. (1994)
Morogoro—Magogoni (28), **Morogoro** (29), Mvuha (30)	Dirlam et al. (1992)
Morogoro—**Mahenge** (19)	Dirlam et al. (1992), Keller (1992)
Morogoro—**Matombo** (27)	Hänni and Schmetzer (1991), Keller (1992), Suleman et al. (1994)
Pwani—Ndundu (37)	Suleman et al. (1994)
Ruvuma—Songea: *Amanimakoro* (42); **Tunduru**: *Muhuwesi River* (2)	Henn and Milisenda (1997), Milisenda et al. (1997), Hamid et al. (1999)
Tanga—Handeni: *Kwachaga* (7)	Keller (1992), Suleman et al. (1994)
Tanga—Umba Valley (21)	Dirlam et al. (1992), Keller (1992)
Tanga—Usambara Mountains (21)	Barot et al. (1995)
◆ **Asia**	
Afghanistan	
Kabul—Jegdalek–Gandamak: *Mirkhalwat, Warmankai* (7)	Hughes (1994, 1997), Bowersox and Chamberlin (1995), Aboosally (1999), Bowersox et al. (2000)
Cambodia	
Battamberg—**Pailin**: *Phnum Ko Ngoap, Phnum O Tang, Phnum Yat, Samlot* (1)	Clark (1992), Hughes (1997)
China	Galibert and Hughes (1995)
Heilongjiang	
Qinghai	
Sichuan—Nanjiang	
Xinjiang—Kalpin	
Yunnan—Yuan Jiang: *Ailao Mountains*	
India	Hughes (1997)
Andhra Pradesh—Anantapur: *Hindupur, Kodegapali* (20); Guntur (56); Khaman: *Gobbugurti, Rangapur* (1); Warangal (43)	Current mining report... (1998)
Andhra Pradesh—Chittoor: *Polichettipalli, Yeracheruvupalli* (44); Nalgonda: *Lingampalli, Timmapur* (61)	S. Fernandes (pers. comm., 1999)
Andhra Pradesh—Vishakhapatnam (3)	Current mining report... (1998), Kasipathi et al. (1999)
Karnataka—Bellary (45); Chitradurga (47); Mandya: *Kollur* (48); Raichur (49); Shimoga (50)	Viswanatha (1982)
Karnataka—Chikmagalur (46); Hassan: *Nuggahalli* (34); Madikeri (60)	Viswanatha (1982), Current mining report... (1998)
Karnataka—Mysore: *Dughahalli, Ramanahalli* (33)	Viswanatha (1982), Choudhuri and Gurachary (1993), Current mining report... (1998)
Karnataka—Tumkur: *Pavugada, Sriangapura* (35)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Bastar: *Bhopalpatnam* (51)	Current mining report...(1998)
Madhya Pradesh—Raipur: *Jagdalpur* (4); Sidhi: *Karkota, Pipra* (64)	S. Fernandes (pers. comm., 1999)
Orissa—Bagdihi (24); Sambalpur: *Meghpal, Ranchipada* (5)	S. Fernandes (pers. comm., 1999)
Orissa—Kalahandi: *Hinghilibahal, Jhillindghar* (53)	Panjikar (1997b)
Tamil Nadu—Kangayam (54); Karur: *Chinnadharapuram, Manvadi* (54); Madurai: *Kodaicanal, Oddanchattram* (7); Palni (55); Salem: *Chalasiramani, Dharampuri, Namakkal, Sitampundi* (17)	S. Fernandes (pers. comm., 1999)
Laos	
Annam Highlands—Ban Huai Sai (1)	Bosshart (1995), Kammerling et al. (1995c), Hughes (1997)
Myanmar	
Kachin—Lonkin: *Nanyaseik, Tanai* (15)	Kammerling et al. (1994b)
Kachin—Mansi: *Molo* (16)	U Hlaing (pers. comm., 1999)
Karen—Belin Thandaung (17)	Kammerling et al. (1994b)
Karen—Hlaingbwe River Valley: *Dawna Hills* (14)	Hlaing (1997)
Mandalay—**Mogok** (numerous deposits) (1)	Kane and Kammerling (1992), Kammerling et al. (1994b), Hughes (1997), Waltham (1999)
Sagaing—Madaya: *Sagyin Hills* (13)	Kammerling et al. (1994b)
Sagaing—Thabeitkyin: *Wa Byu Taung* (12)	U Hlaing (pers. comm., 1999)
Shan—Lai Hka: *Wan Ying* (8), Langhko: *Wan Hat* (10); Namhsan: *Nawarat* (9); Yawnghwe (11)	U Hlaing (pers. comm., 1999)
Shan—Momeik (Mong Mit) (2)	Kammerling et al. (1994b)
Shan—**Mong Hsu** (numerous deposits) (3)	Hlaing (1993, 1994), Smith and Surdez (1994), Smith (1995), Peretti et al. (1995, 1996), Hughes and Galibert (1999)
Nepal	
Gandaki—Ganesh Himal: *Dhading* (2)	Niedermayr (1992), Smith et al. (1997)
Pakistan	
Northern Areas—Hunza Valley (8)	Blauwet et al. (1997)
Northwest Frontier—Hari Parbat Mountains: *Nangimali* (10)	Rice (1996), Kane (1997)
Russia	
Polar Ural Mountains—Rai-Iz: *Makar-Ruz*	Shelton (1988), Spiridonov (1998)
Sri Lanka	Milisenda and Henn (1999)

At this open-pit ruby and sapphire mine near Mogok, Myanmar, portions of the original outcrop can still be seen near the "spirit house" in the center. Photo by Edward Boehm, March 1993.

Gem material/locality	Reference
Central—Nuwara Eliya: *Maskeliya* (15)	
Southern—Monaragala: *Embilipitiya* (19), *Okkampitiya* (5); Ratnapura: *Eheliyagoda* (25), *Pelmadulla* (1), *Rakwana* (3), *Ratnapura* (1)	
Tajikistan	
Turkistan—Pamir Mountains: *Nadezhda, Turakuloma*	Henn et al. (1990b), Smith (1998), Spiridonov (1998)
Turkistan—Pamir Mountains: *Rangkul, near Murgab*	Smith and Smith (1995)
Thailand	
Chanthaburi–Trat—Klung-Khao Saming: *Ba Waen, Bo I Rem, Bo Rai, Na Wong, Nong Bon, Tok Prom* (1)	Hughes (1997)
Vietnam	Kane et al. (1991), Kammerling et al. (1994a)
Nghe An—Bu Khang: *Quy Chau* (3)	
Yen Bai—**Luc Yen**: *Khoan Thong, Nuoc Ngap* (2)	Henn (1991)
◆ Australia	
New South Wales—Barrington (9)	Sutherland (1996), Sutherland and Coenraads (1996), Sutherland et al. (1999)

The fine sapphires in these earrings (approximately 16 ct each) are from Myanmar, and reportedly are untreated. Photo © Tino Hammid and Christie's Hong Kong.

CORUNDUM—Sapphire

◆ Africa	
Kenya	Keller (1992), Hughes (1997)
Central—Thika: *Chania River* (6)	
Eastern—Chandler's Falls: *Kubi Kano* (18); Garba Tula (17); Mtitio Andei: *Kinyiki Hill* (10)	
Rift Valley—Lodwar (5); Loldaika Hills: *Don Dol* (19); Maralal: *Samburu* (9); Murua Rith Hills, Pelekech Mountains (11); West Pokot (16)	
Madagascar	
Antananarivo—Antanifotsy (10)	Henn et al. (1999b), Pezzotta (1999)
Antsiranana—Ambilobe (12)	Pezzotta (1999)
Antsiranana—**Ambondromifehy**: *Amboud–rohefeha* (17)	Gonthier (1997), Superchi et al. (1997), Henn et al. (1999b), Schwarz et al. (2000)
Antsiranana—Milanoa (13)	Superchi et al. (1997), Pezzotta (1999), Laurs (2000)
Fianarantsoa—Andranolava (23)	Henricus (1999)
Fianarantsoa—**Ilakaka–Sakaraha** (23)	Hänni (1999), Henn et al. (1999a,b), Johnson et al. (1999b), Schmetzer (1999b), Laurs (2000)
Toliara—Amboasary (14), Bekily (26)	Henn et al. (1999b), Pezzotta (1999)
Toliara—**Andranondambo** (15)	Kiefert et al. (1996), Milisenda and Henn (1996), Schwarz et al. (1996b), Gübelin and Peretti (1997)
Toliara—Antsiermene (15)	Schwarz et al. (1996b)
Toliara—Betroka (27)	Koivula et al. (1992b), Henn et al. (1999b)
Malawi	
Southern—Chimwadzulu Hill (2)	Henn and Bank (1990), Henn et al. (1990a), Emmett (2000)
Nigeria	
Kaduna—Jemaa	Kanis and Harding (1990)
Mabila	Y. Melas (pers. comm., 2000)
Rwanda	
Cyangugu (1)	Krzemnicki et al. (1996)
Tanzania	
Morogoro—Magogoni (28), Mahenge (19), Mvuha (30)	Dirlam et al. (1992)
Morogoro—Matombo (27)	Keller (1992)
Ruvuma—**Songea**: *Amanimakoro* (42)	Suleman et al. (1994), Kammerling et al. (1996)
Ruvuma—**Tunduru** (2)	Suleman (1995), Henn and Milisenda (1997), Milisenda et al. (1997), Burford (1998)
Singida—Singida (11)	Keller (1992)
Tanga—Handeni (7), **Umba Valley** (21)	Dirlam et al. (1992), Keller (1992)
Tanga—Kalalani (21)	Seifert and Hyrsl (1999)
◆ Asia	
Afghanistan	
Kabul—Jegdalek–Gandamak (7)	Bowersox and Chamberlin (1995), Bowersox et al. (2000)
Cambodia	Hughes (1997)
Battambang—**Pailin**: *Phnum Ko Ngoap, Phnum O Tang, Phnum Yat* (1)	Ngu and Ngoc (1986), Sutherland et al. (1998)
Cardamom—Chamnop (3)	
Ratanakiri—Virochey: *Bo Kham, Bokeo, Voeune Sai* (2)	
Rovieng—Chamnom (4)	
China	Galibert and Hughes (1995)
Hainan—Penglai-Wenchang	
Heilongjiang—Mulan	
Jiangsu—**Fujian**: *Mingxi*; Liuhe	
Qinghai	
Shandong—Changle: *Wutu*	Guo et al. (1992)
Xinjiang Uygar—Taxkorgan	
India	Hughes (1997)
Andhra Pradesh—Anantapur (20), Kakinada (62), Nellore (18)	Viswanatha (1982)
Andhra Pradesh—Khaman (1)	Viswanatha (1982), Panjikar (1998)
Jammu and Kashmir—Kargil: *Soomjam* (12)	Hänni (1990), Panjikar (1997a), Current mining report... (1998)
Karnataka—Hassan (34), Kolar (32), Mysore (33), Tumkur (35)	Viswanatha (1982)
Kerala—Travancore (69)	Viswanatha (1982)
Kerala—Trivandrum (9)	Menon et al. (1994), Rajesh-Chandran et al. (1996)
Orissa—Kalahandi: *Banjipadar, Sargiguda* (53)	S. Fernandes (pers. comm., 1999)
Orissa—Nawapada: *Amera, Katamal* (63)	Patnaik (1993)
Tamil Nadu—Kangayam: *Chinnadharapuram, Malaipatti* (54)	S. Fernandes (pers. comm., 1999)
Kazakhstan	
Qaraghandy—Semizbugy	Shelton (1988)
Laos	
Annam Highlands—Ban Huai Sai (1)	Bosshart (1995), Kammerling et al. (1995c)
Myanmar	Hughes and Win (1995), Hughes (1997)
Kachin—Lonkin: *Nanyaseik* (15)	Kammerling et al. (1994b)
Kachin—Mansi: *Panhka* (16)	U Hlaing (pers. comm., 1999)
Mandalay—Mogok (numerous deposits) (1)	Kane and Kammerling (1992), Kammerling et al. (1994b)

Gem material/locality	Reference
Sagaing—Hlaingbwe River Valley: *Dawna Hills* (14); Singu: *Chaung-Gyi, New-Yan* (19); Thabeitkyin: *Kyauk Kyi, Kyauksaikan* (12)	U Hlaing (pers. comm., 1999)
Shan—Momeik (Mong Mit) (2)	Kammerling et al. (1994b)
Shan—Mong Hkak: *Mong Hkak, Mong Hynin* (18)	Hlaing (1993), Kammerling et al. (1994b)
Shan—Mong Hsak: *Mong Hsak River* (28); Mong Hsu: *Wan Kan* (3)	U Hlaing (pers. comm., 1999)
Nepal	
Gandaki—Ganesh Himal: *Dhading* (2)	Smith et al. (1997)
Russia	
Far East—Primorski Krai: *Kedrovka*	Y. Shelementiev (pers. comm., 1999)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999), E.G. Zoysa (pers. comm., 1999)
Central—Badulla: *Bibile* (33), *Haputale* (18), *Koslanda* (18), *Lunugala* (33), *Passara* (16); Kegalla: *Avissawella* (9); Matale: *Matale* (7); Nuwara Eliya: *Hatton* (15), *Kuruwitenna* (13), *Maskeliya* (15), *Nawalapitiya* (29), *Nuwara Eliya* (22), *Talawakele* (15); Polonnaruwa: *Elahera* (8), *Kalahagala* (14), *Kaluganga Valley* (8)	
Southern—Hambantota: *Ambalantota, Ridiyagama* (11); Kalutara: *Alutgama* (10), *Horana* (34); Matara: *Akuressa, Morawaka* (4); Monaragala: *Amarawewa* (17), *Embilipitiya* (19), *Kataragama* (17), *Kochchikatana* (17), *Kochipatana* (6), *Monaragala* (6), *Okkampitiya* (5); **Ratnapura**: *Balangoda* (2), *Eheliyagoda* (25), *Kiriella, Nivitigala, Pelmadulla* (1), *Rakwana* (3), *Ratnapura* (1)	
Tajikistan	
Turkistan—Pamir Mountains: *Turakuloma*	Smith (1998)
Thailand	Hughes (1997)
Chanthaburi—Tha Mai: *Bang Kha Cha, Khao Ploi Waen, Khao Wao* (1)	
Chanthaburi–Trat—Klung-Khao Saming: *Bo I Rem* (1)	
Kanchanaburi—Bo Phloi: *Ban Chang Dan, Bo Phloi* (2)	Schlüssel (1991)
Phetchabun—Wichian-Buri: Ban *Khok Samran, Ban Marp Samo, Khlong Yang* (3)	
Phrae—Denchai–Wang Chin: *Ban Bo Kaeo, Huai Mae Sung* (4)	Vichit (1992)
Sukothai—Si Satchanalai: *Ban Huai Po, Ban Pak Sin, Ban Sam Saen* (6)	
Ubon Ratchanthani–Si Sa Ket—Nam Yun–Kantharalak (5)	
Vietnam	Kane et al. (1991), Hughes (1997)
Binh Thuan—Phan Thiet: *Da Ban, Ma Lam* (4)	Smith et al. (1995)
Dong Nai—Xa Gia Kiem: *Gia Kiem, Sau Le, Tien Co, Xa Vo* (5)	
Lam Dong—Di Linh: *Binh Dien, Di Linh* (6)	Smith et al. (1995)
Nghe An—Bu Khang: *Bu Khang, Qui Hoop, Quy Chau* (3)	Kammerling et al. (1994a)
Thanh Hoa—Xuan Le: *Thong Luan* (3)	
Yen Bai—Luc Yen: *Hin Om, Khau Sum, Khoan Thong, Lung Thin, Nuoc Lonh, Nuoc Ngap, Phai Chep* (2)	Kammerling et al. (1994a)
◆ Australia	
New South Wales—Barrington (9)	Sutherland and Coenraads (1996), Webb (1997), Sutherland et al. (1998, 1999)
New South Wales—**New England Range**: *Glen Innes, Inverell* (10)	Oakes et al. (1996), Sutherland (1996), Hughes (1997), Aboosally (1998), Neville and von Gnielinski (1999), Sutherland et al. (1999)
New South Wales—Oberon: *Vulcan State Forest* (11)	F. L. Sutherland (pers. comm., 1999)
Queensland—**Anakie–Rubyvale**: *Anakie* (31)	Duffy (1995), Wilson (1995), Aboosally (1998), Neville and von Gnielinski (1999)
Queensland—Lava Plains (30)	Neville and von Gnielinski (1999)
◆ North America	
Canada	Wight (1999a)
British Columbia—Slocan Valley: *Passmore (Blu Moon, Blu Starr, Sapphire Hill)*	Wilson (1999), Coenraads and Laird (2000)
Labrador	
United States	Hughes (1997)
Montana—Deer Lodge: *Dry Cottonwood Creek*	Hughes (1995)
Montana—**Granite**: *Rock Creek*	Emmett and Douthit (1993)
Montana—**Judith**: *Yogo Gulch*	Allen (1991), Mychaluk (1995)
Montana—Lewis and Clark (along Missouri River): *American Bar, Dana Bar, Eldorado Bar, Emerald Bar, French Bar, Magpie Gulch, Metropolitan Bar, Spokane Bar*	Sinkankas (1997)
◆ South America	
Brazil	
Minas Gerais—Indaiá (18)	Epstein et al. (1994), Henn et al. (1994)
Colombia	
Cauca—Mercaderes (2)	Johnson et al. (2000b)
DIAMOND	
◆ Africa	
Angola	Levinson et al. (1992), Janse (1995)
Lunda Norte—**Andrada**: *Catuca (Catoca)* (3); Maxinje: *Cuango River* (2)	
Lunda Norte—**Andrada**: *Chitotolo* (3)	Ambroise (1998)
Lunda Norte—**Chicapa and Luachimo Rivers**: *Caixepa, Camafuca, Camagico, Camatchia, Camatue* (1)	Khar'kiv et al. (1992)
Malanje—Banano (4)	A. Janse (pers. comm., 1999)
Botswana	Janse (1995, 1996)
Central—**Orapa**: *Letlhakane, Orapa* (1)	Levinson et al. (1992), Duval et al. (1996)
Ghanzi—Ghanzi: *Gope* (4)	
Kweneng—**Jwaneng**: *Jwaneng* (2)	
Ngamiland—Tsodilo Hills (3)	A. Janse (pers. comm., 1999)
Central African Republic	Levinson et al. (1992), Janse (1995)
Haute-Kotto—Mouka Quadda	
Haute-Sangha—Berbérati-Carnot: *Mambere River*	Censier and Tourenq (1995)
Democratic Republic of the Congo (Zaire)	
Bandundu—Kwango (Cuango) River (1)	A. Janse (pers. comm., 1999)
Kasai Occidental—Tshikapa: *Kasai River* (2)	Janse (1995)
Kasai Oriental—Mbuji-Mayi: *Bushimaie River, Miba, Talala* (3)	Janse (1995)
Ghana	
Ashanti—Akwatia: *Birim River*	Levinson et al. (1992), Janse (1996), Stachel and Harris (1997)
Guinea	
Région Forestière—Baloue River Valley: *Trivalence*	Levinson et al. (1992), Janse (1996)
Région Forestière—Diani River Valley: *Aredor, Hymex*	A. Janse (pers. comm., 1999)
Côte d'Ivoire	Janse (1996)
Korhogo—Tortiya	
Seguela—Seguela	Levinson et al. (1992)
Mali	
Kayes—Kéniéba	Janse (1996)
Namibia	
Lüderitz—**Orange River**: *Auchas, Daberas* (4)	Janse (1995)
Lüderitz—**Oranjemund**: *Sperrgebiet (Elizabeth Bay, Namdeb, and other marine deposits)* (3)	Gurney et al. (1991), Levinson et al. (1992), Wannenburgh (1995), Duval et al. (1996)
Sierra Leone	
Eastern—Bafi and Sewa Rivers	Levinson et al. (1992), Duval et al. (1996), Janse (1996)
Eastern—Koidu: *Tongo*	A. Janse (pers. comm., 1999)
South Africa	Levinson et al. (1992)

Gem material/locality	Reference
Cape—**Kimberley**: *Barkley West, Bellsbank, Bultfontein, Dutoitspan, Kimberley, Wesselton* (2); Orange River: *Baken*; **Postmasburg**: *Finsch* (1)	Janse (1995, 1996)
Cape—**Namaqualand**: *Benguela, Kleinzee, and other marine deposits* (3)	Gurney et al. (1991), Levinson et al. (1992), Duval et al. (1996)
Orange Free State—**Koffiefontein**: Koffiefontein (4)	Janse (1995, 1996)
Orange Free State—Theunissen: *Star* (8)	A. Janse (pers. comm., 1999)
Transvaal—**Messina**: *Venetia* (6); **Pretoria**: *Marsfontein, Oaks, Premier* (5)	Janse (1995, 1996)
Tanzania	
Shinyanga—**Shinyanga**: *Mwadui (Williamson)* (12)	Dirlam et al. (1992), Levinson et al. (1992), Janse (1996)
Zimbabwe	
Matabeleland South—Limpopo River: *River Ranch* (3)	Duval et al. (1996)
◆ Asia	
China	Steiner (1997)
Hunan—Yuan River	R. Li (pers. comm., 1999)
Liaoning—Fuxian	Janse (1995)
Shandong—Mengyin: *Changma*	Dobbs et al. (1994)
Shandong–Jiangsu—Linshu (Xiazhuang)	A. Janse (pers. comm., 1999)
India	Babu (1998)
Andhra Pradesh—Anantapur: *Chigicherla-Gollapalle, Lattavaram, Vajrakurur* (20); Krishna: *Lower Krishna River Valley* (2); Kurnool: *Banganapalle, Middle Krishna River Valley, Munimadagu* (22); Mahbubnagar: *Kotakonda, Maddur* (23)	
Madhya Pradesh—Bastar: *Bhejripadar* (51), *Indravati River* (26), *Tokapal* (51); Raipur: *Bahradih, Jangra, Kodomali, Payalikhand* (4)	
Madhya Pradesh—Panna: *Hinota, Majhgawan* (25)	Chatterjee and Rao (1995)
Maharashtra—Garhchiroli (58)	Choudhuri and Gurachary (1993)
Orissa—Balangir: *Mahanadi River* (10)	Garlick (1993)
Orissa—Bhawanipatna (27)	J. Panjikar (pers. comm., 1999)
Orissa—Sambalpur: *Tel River* (5)	
Rajasthan—Chittaurgarh (28)	Choudhuri and Gurachary (1993)
Uttar Pradesh—Jungel Valley (59)	Viswanatha (1982)
Uttar Pradesh—Mirzapur (29)	Choudhuri and Gurachary (1993)
Indonesia	Levinson et al. (1992), Duval et al. (1996)
Borneo—Kalimantan, Selatan: *Martapura*; Tengah: *Maurateweh*	Janse and Sheahan (1995)
Borneo—Kalimantan-Barat: *Pontianak–Landak*	Spencer et al. (1988)
Myanmar	
Kachin—Lonkin: *Nanyaseik* (15)	Pers. knowl. of author (GB)
Kachin—Putao (4)	Kammerling et al. (1994b)
Kachin—Tanaing (20)	U Hlaing (pers. comm., 1999)
Pegu—Toungoo (21)	Hlaing (1990b), Kammerling et al. (1994b), Hlaing and Win (1997)
Shan—Momeik (Mong Mit): *Bo Dae, Kyeintaw, Mohawk* (2)	Hlaing (1990b), Kammerling et al. (1994b), Hlaing and Win (1997), pers. knowl. of author (GB)
Tenasserim—Taninthari River: *Theindaw* (5)	Hlaing (1990b), Kammerling et al. (1994b), Hlaing and Win (1997)
Tenasserim—Tavoy River (5)	Kammerling et al. (1994b)
Russia	Strand (1991), Spiridonov (1998)
Arkhangelsk—Zimniy Bereg: *Kepinskoye, Verkhotinskaya*	Possoukhova et al. (1999)
Arkhangelsk—Zimniy Bereg: *Zolotitskoye*	Smirnov (1993), Evseev (1994a), Sinitsyn et al. (1994), Yushkin (1996)
Middle Ural Mountains—Vischera River	Shelton (1988)
Yakutia (Sakha)—**Anabar**: *Kuonamka River*; **Nyurba**: *Botuobinskaya, Nurbunskaya*	A. Janse (pers. comm., 1999)
Yakutia (Sakha)—**Daldyn-Alakit**: *Aikhal, Krasnupresnenskaya, Sytakanskaya, Udachnaya, Yubileynaya, Zarnitsa*; **Malaya-Botuobiya**: *Internatsionalnaya, Mir, Sputnik*	Levinson et al. (1992), Duval et al. (1996)
◆ Australia	Levinson et al. (1992)
New South Wales—New England: *Bingara, Copeton* (14)	Barron et al. (1996), Meyer et al. (1997), Webb and Sutherland (1998)
Northern Territory—Battan: *Merlin* (18)	Jaques (1994), Lee et al. (1997, 1998)
Western Australia—Central Kimberley: *Aries* (16)	Edwards et al. (1992), Towie et al. (1994)
Western Australia—East Kimberley: **Argyle** (17)	Chapman et al. (1996), Pardon (1999)
Western Australia—East Kimberley: *Bow River* (17); North Kimberley: *Upper Bulgurri River* (12)	A. Janse (pers. comm., 1999)
Western Australia—West Kimberley: *Ellendale* (15)	Jaques (1994)
◆ North America	
Canada	
Northwest Territories—Lac de Gras: *Ekati*	Levinson et al. (1992), Pell (1994)
United States	
Arkansas—Pike: *Murfreesboro*	
Wyoming–Colorado—Fort Collins: *Kelsey Lake*	Johnson and Koivula (1996c), Hausel (1997), Sinkankas (1997)
◆ South America	
Brazil	
Mato Grosso—Alto Paraguai: *Nortelândia* (25)	Cassedanne (1989)
Mato Grosso—Aripuanã: *Juina* (25)	
Minas Gerais—Diamantina: *Campo do Sampaio, Datas, Extração, Guinda, São João da Chapada, Sopa* (26); Jequitai (27); Jequitinhonha River Valley: *Grão Mogol, Itacambira–Rio Macaúbas, Serro do Cabral* (18)	Cassedanne (1989), Karfunkel et al. (1994, 1996), N. Haralyi (pers. comm., 1998)
Minas Gerais—Triângulo Mineiro: *Abaeté River, Coromandel* (28)	Cassedanne (1989), Gonzaga et al. (1994), Karfunkel et al. (1994)
Pará—Tocantins River (6)	Cassedanne (1989)
Roraima—Branco River: *Tepequém* (29)	Meyer and McCallum (1993)
Guyana	Levinson et al. (1992), Meyer and McCallum (1993)
Cuyuni–Mazaruni—Cuyuni River, Mazaruni River (1)	
Potaro–Sirapuni—Potaro River (2)	
Venezuela	Levinson et al. (1992), Meyer and McCallum (1993), Heylmun (1994, 1995)
Bolívar—Caroní River (2), Cuyuní River (1), Paragua River (2)	
Bolívar—Guaniamo River: *Guaniamo, Quebrada River* (3)	Coenraads et al. (1994), Taylor (1999)

GARNET

◆ Africa

Eritrea	
Asmera—Sciumagalle	Milisenda and Hunziker (1999)
Ethiopia	
Sidamo—Chumba	Barot (1993)
Kenya	
Coast—Mgama-Mindi: *GG, Gitshure, Lualenyi, Minkeno, Scorpian* (21)	Kane et al. (1990), Keller (1992)
Coast—Taita Taveta (4)	Barot et al. (1995)
Rift Valley—Lodwar: *Lokirima* (5)	Barot (1993)
Madagascar	
Antananarivo—Betafo (2)	Henn et al. (1999b)
Antananarivo—Sahatany Valley (3)	Henn et al. (1999b), Pezzotta (1999)
Fianarantsoa—Ambositra (16), Ambovombe (28), Ihosy (29), Ranohira (23)	Henn et al. (1999b)
Fianarantsoa—**Ilakaka–Sakaraha** (23)	Hänni (1999), Henn et al. (1999b)
Mahajanga—Maevatanana (25)	Johnson and Koivula (1998h)
Mahajanga—Mahajanga (30)	Henn et al. (1999b), Pezzotta (1999)
Toamasina—Maralambo (31)	Johnson and Koivula (1998f)
Toliara—Ampanihy (32), Itrongay (43), Tolanaro (21)	Henn et al. (1999b)
Toliara—Bekily (26)	Henn (1999), Schmetzer and

Gem material/locality	Reference
	Bernhardt (1999)
Toliara—Betroka (27)	Henn et al. (1999b), Pezzotta (1999)
Toliara—Gogogogo (8)	Mercier et al. (1997)
Malawi	
Northern—Mzimba (1)	C. Hedegaard (pers. comm., 1998)
Mali	
Kayes—Diakon	Brightman and Tunzi (1995), Johnson et al. (1995), Lind et al. (1995), Johnson and Koivula (1997b, 1998e)
Mozambique	
Niassa—Cuamba (4)	Johnson and Koivula (1996d), Malango and Taupitz (1996), Bank et al. (1998)
Namibia	
Kaokoveld—**Hartmann Mountains**: *Kunene River* (6)	Koivula et al. (1993e), Lind et al. (1993), Kammerling et al. (1995d), Johnson and Koivula (1996h)
Karibib—Usakos: *Usakos* (8)	Johnson and Koivula (1997e)
Outjo—Damara Mountains (5)	Wenk (1997), Lind et al. (1998)
Nigeria	
Oyo—**Ogbomosho**: *Iseyin*	Milisenda and Zang (1999), Zang et al. (1999)
Tanzania	
Arusha—Kangala: *Loiborsoit* (14)	Suleman et al. (1994)
Arusha—Komolo: *Komolo* (14)	Keller (1992)
Arusha—Lelatema: *Lelatema Mountains* (3)	Dirlam et al. (1992), Keller (1992)
Arusha—Merelani (15)	Dirlam et al. (1992), Kane et al. (1991)
Arusha—Tiriti (31)	Dirlam et al. (1992), Suleman et al. (1994)
Dodoma—Mpwapwa (5)	Dirlam et al. (1992)
Kilimanjaro—Pare Mountains (16)	Keller (1992)
Kilimanjaro—Same: *Lemkuna* (17)	Dirlam et al. (1992)
Lindi—Lindi: *Luisenfelde, Nambunju* (18)	Keller (1992)
Lindi—Ruangwa (39)	McClure (1999)
Morogoro—Magogoni (28), Mahenge (19), Mvuha (30)	Dirlam et al. (1992)
Mtwara—Masasi: *Namaputa* (20)	Dirlam et al. (1992), Keller (1992)
Ruvuma—**Tunduru** (2)	Milisenda et al. (1997)
Tanga—Handeni (7)	A. Suleman (pers. comm., 1999)
Tanga—Kalalani (21)	Seifert and Hyrsl (1999)
Tanga—Umba Valley (21)	Dirlam et al. (1992), Keller (1992)
Tanga—Usambara Mountains (21)	Barot et al. (1995)
Zambia	
Central—Serenje (8)	Mambwe and Sikatali (1994)
Eastern—Lundazi (2)	Johnson et al. (1999c)
Eastern—Nyimba (7)	Mambwe and Sikatali (1994)
Southern—Gwembe (9); Mazabuka: *Nega Nega* (10)	Mambwe and Sikatali (1994)
◆ Asia	
Azerbaijan	
Caucasus Mountains—Dashkesan	Smith and Smith (1995), Spiridonov (1998)
China	
Jiangsu—Donghai	
Qinghai—Qui Lien Mountains	
Xinjiang Uygur—Altai Mountains: *Cocoktau, Qibeiling*	Wang and Liu (1994)
Yunnan	More new finds... (1996)
India	
Andhra Pradesh—Araku Valley (42)	S. Fernandes (pers. comm., 1999)
Andhra Pradesh—Khaman (1), Krishna River (2)	Viswanatha (1982)
Andhra Pradesh—Vishakhapatnam (3)	Viswanatha (1982), Kasipathi et al. (1999)
Karnataka—Hassan (34), Mysore (33)	Viswanatha (1982)
Kerala—Ernakulam (36), Travancore (69)	Viswanatha (1982)
Madhya Pradesh—Bastar: *Dampaya, Kuchnur* (51); Betul: *Bisighat, Chunabhuru* (52)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Deobhog: *Jagdalpur* (19)	Jha et al. (1993)
Orissa—Angul: *Jhilli, Magarmuhan, Nuagaon* (37)	Das et al. (1993), Jha et al. (1993)
Orissa—Deogarh: *Jharposi* (5); Kalahandi: *Ghatpara, Singhjaran* (53); Nawapada: *Dhamjar, Sardhapur* (63); Subarnapur: *Naktamunda, Siali* (10)	Das et al. (1993), S. Fernandes (pers. comm., 1999)
Orissa—Sambalpur: *Bagdhapa, Meghpal* (5)	Das et al. (1993), Current mining report... (1998)
Rajasthan—Ajmer (14)	Viswanatha (1982), Current mining report... (1998)
Rajasthan—Bhilwara (39)	S. Fernandes (pers. comm., 1999)
Rajasthan—Chittaurgarh (28), Tonk (15)	Current mining report... (1998)
Rajasthan—Jaipur (40), Jodhpur (41), Udaipur (16)	Viswanatha (1982)
Tamil Nadu—Karur: *Manavadi* (54); Salem (17)	Viswanatha (1982)
Tamil Nadu—Madurai: *Oddanchattram* (7)	S. Fernandes (pers. comm., 1999)
Kazakhstan	
Qaraghandy	Shelton (1988), Evseev (1994a), Smith and Smith (1995)
Myanmar	Hughes (1997)
Kachin—Putao: *Sankawng* (4)	U Hlaing (pers. comm., 1999)
Kayah—Bawlake: *Bawlake River* (27)	U Hlaing (pers. comm., 1999)
Mandalay—Mogok: *Kyat-Pyin* (1)	Kammerling et al. (1994b)
Sagaing—Pyawbwe: *Pyawbwe East* (22)	U Hlaing (pers. comm., 1999)
Shan—Lai Hka (8), Mong Kang (23), Mong Mit (2), Namhkan (24)	U Hlaing (pers. comm., 1999)
Shan—Mong Hsak (28)	Hlaing and Win (1996)
Pakistan	Blauwet et al. (1997)
Northwest Frontier—Neelum Valley (9)	Henn (1996), Johnson and Koivula (1996g)
Northwest Frontier—Swat Valley: *Jambil* (4)	Jackson (1992)
Russia	
Far East—Chukot Peninsula: *Tavmatey*; Kamchatka Penninsula: *Chechatvayam*; Primorski Krai: *Dalnegorsk*	Smith and Smith (1995)
Far East—Primorski Krai: *Sinerechenskoye*	Evseev (1994a), Smith and Smith (1995)
Karelia—Lake Ladoga: *Kitelya*; Shuyeretskoye: *Terbe Island*	Evseev (1994b)
Middle Ural Mountains—Asbest: *Bazenovskoye*;	Smith and Smith (1995),

Nigeria became an important source of spessartine garnet (here, 5–13 ct) and rubellite tourmaline (5–25 ct) at the end of the decade. Courtesy of Pala International and Bill Barker Co.; photo by Robert Weldon.

Gem material/locality	Reference
Perm: *Saranovskoye*	Kolesar (1997)
Middle Ural Mountains—Nizhniy Tagil: *Bobrowka–Bolshaya Rivers*; Verhnij Ufalev: *Karkodino, Poldnevaya*	Shelton (1988), Evseev (1993a), Phillips and Talantsev (1996), Spiridonov (1998)
Siberia— Akhtaragda–Viluy Rivers: *Chernyshevsky*	Evseev (1994a), Smith and Smith (1995), Spiridonov (1998)
Southern Ural Mountains—Zlatoust: *Akhmatovskaya*	Evseev (1993a), Smith and Smith (1995)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18), *Passara* (16); Kegalla: *Avissawella* (9); Nuwara Eliya: *Hatton* (15), *Kuruwitenna* (13), *Maskeliya* (15); Polonnaruwa: *Elahera, Kaluganga Valley* (8), *Kongahawela, Polonnaruwa* (14)	
Southern—Hambantota: *Ambalantota* (11), *Lunugamwehera, Paskema* (30), *Ridiyagama* (11); Kalutara: *Horana* (34); Matara: *Akuressa*, *Morawaka* (4); Monaragala: *Athiliwewa* (20), *Embilipitiya* (19), *Kataragama* (17), *Okkampitiya* (5); Ratnapura: *Balangoda* (2), *Rakwana* (3)	Johnson and Koivula (1996a, 1998a), Chandrajith et al. (1998)
Vietnam	
Yen Bai—Luc Yen (2)	Kammerling and Koivula (1994)
◆ Australia	
Northern Territory—Harts Range (3)	F. L. Sutherland (pers. comm., 1999)
◆ Europe	
Czech Republic	
Bohemia—Bohemian Hills: *Podsedice, Trebenice*	Schluter and Weitschat (1991), Korbel (1993)
◆ North America	
Canada	
British Columbia—McDame	Wilson (1999)
British Columbia—Slocan Valley: *Passmore*	Wight (1999b), Wilson (1999)
Quebec—Asbestos: *Jeffrey*	Sinkankas (1997)
Quebec—Black Lake	Johnson et al. (1999a), Wilson and Wight (1999)
United States	
Alaska—Wrangel: *Stikine River*	Frazier and Frazier (1990c)
California—Ramona: *Little Three*	Foord et al. (1989)
Idaho—Benewah: *Emerald Creek*	Sinkankas (1997)
◆ South America	
Brazil	
Minas Gerais—Galiléia: *Barra do Cuieté* (8)	Johnson and Koivula (1999b)
Minas Gerais—São José da Safira: *Poaia* (19)	R. Wegner and O. Moura (pers. comm., 2000)
Rio Grande do Norte—Carnaúba dos Dantas: *Pedra Bonita* (10)	R. Wegner and O. Moura (pers. comm., 2000)
Tocantins—Valério: *Balisto* (42)	Wegner et al. (1998)
JADE—Jadeite	
◆ Asia	
Japan	Koivula and Kammerling (1990)
Hyogo—Oya	Chihara (1999)
Niigata—Itoigawa: *Hashidate*	
Niigata—Omi: *Himekawa and Kotaki Rivers*	Chihara (1999)
Toyama—Asahi	
Kazakhastan	
Qaraghandy—Itmurundy	Spiridonov (1998)
Myanmar	Htein and Naing (1994, 1995), Kammerling et al. (1994b), Ward (1997), Galibert and Hughes (1999), Hughes et al. (2000)
Kachin—Hpakan: *Hpakan, Hpakangyi, Hwehka, Makapin, Maw-sisa, Sate Mu, Seng Tong, Tawmaw, Uru River* (15); Lonkin (15)	Ou Yang (1999)
Kachin—Laisai (26), Mawhun (25)	
Sagaing—Hkamti: *Nansibon, Natmaw* (6)	
Russia	
Polar Ural Mountains—Rai-Iz: *Karovoye*; Syum-Keu: *Pus'erka*	Yushkin (1996)
Polar Ural Mountains—Voikaro-Syniiskii: *Levokechpelskoye*	Spiridonov (1998)
Siberia (Khahassia)—Sayan Mountains, Sokhatiny: *Borusskoye, Kashkarskoye*	Spiridonov (1998), V. Bukanov and N. Kuznetsov (pers. comm., 2000)
◆ North America	
Guatemala	
El Progresso—Motagua Valley: *Manzanal*	Harlow (1994), Gendron and Gendron-Dadou (1999)
Zacapa—Rio la Palmilla	G. Harlow (pers. comm., 1999)
JADE—Nephrite	
◆ Asia	
China	Wang (1996)
Guangxi	
Jiangxi	
Liaoning—Xiu Lan	
Qinghai–Gansu—Qilian Mountains	
Sichuan	
Taiwan	
Tibet	
Xinjiang Uygur—Altun Mountains; Kunlun Mountains: *Hotan, Yutian*; Tian Mountains	
Russia	
Polar Ural Mountains—Rai-Iz: *Nyrdvomenshor*	Yushkin (1996)
Siberia—Buryatia: *Khamarkhudinskoye*	V. Bukanov (pers. comm., 1999)
Siberia—Sayan Mountains, Vitim River: *Bortogolskoye, Buromskoye, Kurtushubinskoye, Ospinskoye, Paromskoye, Ulankhodinskoye*	Sekerina et al. (1996), Spiridonov (1998), V. Bukanov (pers. comm., 1999)
◆ Australia	
South Australia—Eyre Peninsula: *Cowell* (4)	Ward (1999a)
New Zealand	
South Island—Otago: *Lake Wakatipu*; Westland: *Arahura and Taramakau Rivers*	Keverne (1991)
◆ North America	
Canada	Sinkankas (1997)
British Columbia—**Cassiar Mountains**: *Polar Jade*	Ward (1999a,b)
British Columbia—Kutcho Creek, Ogden Mountain	Ward (1996b, 1999b)
United States	Sinkankas (1997)
Alaska—Afognak Island: *Danger Bay*; Baird Mountains: *Kobuk River*	Howard (1998)
California—Monterey: *Jade Cove*	Paradise (1985), Ward (1999b)
Wyoming—Lander: *Granite Mountains*	Ward (1999b)
OPAL	
◆ Africa	
Ethiopia	
Shewa—Menz Gishe: *Mezezo*	Downing (1996), Hoover et al. (1996), Johnson et al. (1996)
Madagascar	
Beraketa (50)	Henn et al. (1999b)
Tanzania	
Dodoma—Haneti Hills (22)	Keller (1992)
Kigoma—Kasulu (44)	Johnson and Koivula (1998b)
Kilimanjaro—Same (17)	A. Suleman (pers. comm., 1999)
Zambia	
Southern—Lake Kariba: *Maamba* (5)	Milisenda et al. (1994)
◆ Asia	
Indonesia	Lambert and Brown (1994)
Java—Jawa Burat: *Labak*	
Sulawesi—Selatan	
Sumatra—Bengkulu	

Gem material/locality	Reference
◆ Australia	
New South Wales—**Lightning Ridge** (1)	Gübelin (1990), Coenraads (1995)
New South Wales—**White Cliffs** (5)	Coenraads (1995)
Queensland—Carbine Creek (27), Jundah (24), Kynuna (26), Mayneside (25), Opalton (25), Quilpie (7), Toompine (23), Winton (8), Yowah (22)	Wise (1993)
Queensland—Eromanga (6)	Coenraads (1995)
South Australia—**Andamooka** (32), **Coober Pedy** (28)	Townsend (1995)
South Australia—Lambina (29)	Brown et al. (1993)
South Australia—**Mintabie** (28)	Brown (1992), Townsend (1992, 1995)
◆ North America	
Canada	
British Columbia—Vernon: Klinker	Koivula et al. (1993c), Yorke-Hardy (1994), Wight (1999a), Wilson (1999)
Mexico	
Querétaro—Querétaro	Spencer et al. (1992), Sinkankas (1997)
United States	Sinkankas (1997)
Idaho—Lemhi: *Spencer*	
Nevada—Humboldt: *Virgin Valley*	
Oregon—Morrow: *Opal Butte*	Holzhey (1997)
◆ South America	
Brazil	
Bahia	Koivula et al. (1994b)
Piauí—Pedro II (37)	Knigge and Milisenda (1997), Johnson and Koivula (1999c)
Rio Grande do Sul—Capão Grande (4)	Henn and Balzer (1995)
Peru	
Arequipa—Arequipa: *Acarí* (1)	Koivula and Kammerling (1991a,b), Brown (1996)

PERIDOT (Olivine)

◆ Africa	
Ethiopia	
Sidamo—Mega	Kammerling and Koivula (1995b)
Tanzania	
Arusha—Gelai: *Kingiti* (38)	Keller (1992)
◆ Asia	
China	Fashion for green... (1999)
Hebei—Zhangjiakou-Xuanhua	
Jilin—Changbaishan: *Baishishan*	More new finds... (1996)
Myanmar	
Mandalay—Mogok: *Bernardmyo* (1)	Hughes (1997)
Mandalay—Mogok: *Pyaung-Gaung* (1)	Kammerling et al. (1994b)
Pakistan	
Northwest Frontier—**Jalkot Valley, Kohistan**: *Parla Sapat* (7)	Koivula et al. (1994c,e), Milisenda et al. (1995), Frazier and Frazier (1997), Aboosally (1999)
Russia	
Siberia—Khatanga: *Kugda*	V. Bukanov (pers. comm., 1999)
Sri Lanka	
Southern—Monaragala: *Embilipitiya* (19); Ratnapura: *Kolonne* (32)	Milisenda and Henn (1999)
Vietnam	Kammerling and Koivula (1995a)
Annam Highlands—Gai Lai (Pleiku) (7)	
Lam Dong—Di Linh (6)	
◆ North America	
Canada	
British Columbia—Cherryville: *Lightning Peak*	Wilson (1999)
United States	
Arizona—Gila: *San Carlos*	Sinkankas (1997), Poeter (1999)

QUARTZ—Amethyst/Citrine/Ametrine

◆ Africa	
Kenya	
Eastern—Machakos: *Mbooni Hill* (1)	Keller (1992)
Madagascar	Henn et al. (1999b), Pezzotta (1999)
Antananarivo—Anjozorobe (42), Antsirabe (3), Betafo (2), Mahasolo (34), Soavinandriana (11), Tsiroanomandidy (33)	
Antsiranana—Ambilobe (12), Andapa (19)	
Fianarantsoa—Ambatofinandrahana (28); Ambositra (16); Farafangana: *Isamara* (35); Fianarantsoa: *Lacamisinten* (51); Vondrozo (20)	Aurisicchio et al. (1999)
Mahajanga—Boriziny (40), Kandreho (41), Tsaratanana (6)	
Toamasina—Andilamena (37), Mananara (39), Moramanga (38), Vatomandry (36)	
Mozambique	
Nampula—Alto Ligonha (1)	Malango and Taupitz (1996)
Namibia	
Grootfontein—Platveld Siding: *Dan, Okaruhuiput, Platfeld* (9)	Schneider and Seeger (1992), Koivula et al. (1994a)
Swakopmund—Uis: *Brandberg* (1)	Henn and Lieber (1993)
Tanzania	
Arusha—Lelatema (3), Tiriti (31)	Keller (1992)
Arusha—Mbulu (40)	A. Suleman (pers. comm., 1999)
Dodoma—Dodoma: *Mdindo* (4); Kilosa (6)	Keller (1992)
Dodoma—Mpwapwa (5)	Dirlam et al. (1992), Keller (1992)
Morogoro—Mvuha (30)	Dirlam et al. (1992)
Tanga—Handeni: *Negeru, Tamota* (7)	Keller (1992), Suleman et al. (1994)
Zambia	Mambwe and Sikatali (1994)
Central—Mumbwa (12)	
Eastern—Lundazi (2)	
Southern—Kalomo: *Mapatizya, Mwakambiko* (1); Siavonga (11)	
◆ Asia	
Afghanistan	
Kapisa—Del Parian (1)	Bowersox and Chamberlin (1995)
Cambodia	
Ratanakiri—Virochey: *Bo Kham, Voeune Sai, Xempang* (2)	Ngu and Ngoc (1986)
India	
Andhra Pradesh—Warangal (43)	S. Fernandes (pers. comm., 1999)
Jammu and Kashmir—Himachal Pradesh (65)	
Madhya Pradesh—Betul: *Bakka,* Ratera (52); Jabalpur: *Barela* (66)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Deobhog: *Harrakothi* (19)	Jha et al. (1993)
Orissa—Balangir (10)	Choudhuri and Gurachary (1993)
Kazakhastan	
Qaraghandy—Vishnevka	Spiridonov (1998)
Myanmar	
Karen—Hlaingbwe River Valley (14)	U Hlaing (pers. comm., 1999)
Mandalay—Mogok: *Sakangyi* (1)	Kammerling et al. (1994b)
Shan—Makmai: *Wan Salaung* (28)	U Hlaing (pers. comm., 1999)
Russia	
Far East—Bikin: *Bikinskoye*	V. Bukanov (pers. comm., 1999)
Far East—Magadan: *Kedon River*	Smith and Smith (1995)
Kola Peninsula—Tersky Bereg: *Cape Korable*	V. Bukanov (pers. comm., 1999)
Lake Baikal—Ust'-Ilimsk: *Kroshunovskoye*	Smith and Smith (1995)
Middle Ural Mountains—Asbest: *Vatikha*	Evseev (1993b), Smith and Smith (1995), Emlin (1996), Spiridonov (1998)
Polar Ural Mountains—Komi: *Khasavarka*	Evseev (1993b), Spiridonov (1998)
Yakutia (Sakha)—Aldan: *Obman*	V. Bukanov (pers. comm., 1999)

Gem material/locality	Reference
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Anuradhapura: *Kekirawa* (28); Kandy: *Galaha* (26); Kegalla: *Avissawella* (9); Kurunegala: *Kurunegala* (21); Matale: *Rattota* (27); Nuwara Eliya: *Nuwara Eliya* (22)	
Southern—Monaragala: *Embilipitiya* (19); Ratnapura: *Balangoda* (2), *Eheliyagoda* (25), *Rakwana* (3), *Ratnapura* (1)	
Ukraine	
Volyns'ka—Vladimir-Volynsky	Evseev (1994b)
Zhytomyr—Zhytomyr: *Volodarsk-Volnskiy*	Smith and Smith (1995)
◆ North America	
Canada	
British Columbia—Slocan Valley: *Nelson*	Wilson (1999)
Ontario—Thunder Bay: *Keetch, Ontario Gem, Panorama*	Sinkankas (1997), B. Wilson (pers. comm., 1999)
United States	
Arizona—Maricopa: *Four Peaks*	Lurie (1999)
Maine—Oxford	Sinkankas (1997)
Maine—Stow	Koivula et al. (1993d)
New Hampshire—Carroll	Sinkankas (1997)
North Carolina—Lincoln	Sinkankas (1997)
◆ South America	
Bolivia	
Santa Cruz—Rincón del Tigre: *Anahí, Yuruty* (1)	Collyer et al. (1994), Vasconcelos et al. (1994), Marcusson (1996), Krzemnicki (2000)
Brazil	
Bahia—Brejinho (40); Cabeluda (23); Jacobina (2)	R. Batista and D. Epstein (pers. comm., 2000), Couto (2000)
Minas Gerais—Buenópolis (26)	R. Batista and D. Epstein (pers. comm., 2000)
Minas Gerais—Campo Belo (9)	Cassedanne (1995)
Pará—**Marabá**: *Alto Bonito* (11); **Pau d'Arco**: *Villa Esperança* (41)	Cassini et al. (1999)
Rio Grande do Sul—Ametista do Sul	Priester (1999)
Rio Grande do Sul—**Santa Maria**: *Planalto* (12)	Balzer (1999)
Rondônia—Porto Velho (7)	R. Batista and D. Epstein (pers. comm., 2000)
Roraima—São Luis de Anawa	R. Batista and D. Epstein (pers. comm., 2000)
Uruguay	
Artigas—Artigas (1)	Sosso and Roman (1992), Currier (1997)

QUARTZ—Rose

◆ Africa	
Madagascar	Henn et al. (1999b)
Antananarivo—Faratsiho (44), Sahatany Valley (3)	Pezzotta (1999)
Antananarivo—Tsiroanomandidy (33)	
Fianarantsoa—Ambositra (16)	Pezzotta (1999)
Toamasina—Ambatondrazaka (22), Moramanga (38)	
Toamasina—Andilamena (37)	
Mozambique	
Nampula—Alto Ligonha (1)	Malango and Taupitz (1996)
Namibia	
Swakopmund—Swakopmund: *Hoffnungsstrahl, Roselis* (7)	Schneider and Seeger (1992)
◆ Asia	
India	
Karnataka—Mysore (33)	S. Fernandes (pers. comm., 1999)
Madyha Pradesh—Deobhog (19)	Jha et al. (1993)
Tamil Nadu—Kangayam-Karur (54), Salem (17)	S. Fernandes (pers. comm., 1999)
◆ North America	
United States	
South Dakota—Black Hills	Sinkankas (1997)
◆ South America	
Brazil	
Minas Gerais—Sapucaia do Norte: *Sapucaia* (8)	B. Cook (pers. comm., 2000)

SPINEL

◆ Africa	
Madagascar	
Fianarantsoa—**Ilakaka–Sakaraha** (23)	Schmetzer (2000)
Toliara—Betroka (27)	Henn et al. (1999b), Pezzotta (1999)
Tanzania	
Morogoro—Magogoni (28), Mahenge (19), Matombo (27), Mvuha (30)	Dirlam et al. (1992), Keller (1992)
Ruvuma—Songea (42)	Dirlam et al. (1992)
Ruvuma—**Tunduru** (2)	Milisenda et al. (1997), Thomas (1997), Burford (1998)
Tanga—Handeni: *Kwachaga* (7)	Keller (1992)
Tanga—Umba Valley (21)	Dirlam et al. (1992), Keller (1992)
◆ Asia	
Afghanistan	Bowersox and Chamberlin (1995)
Badakhshan—Kuh-i-Lal (8)	
Kabul—Jegdalek (7)	Hughes (1994)
Cambodia	
Battamberg—Pailin (1)	
Myanmar	
Kachin—Mansi: *Panhka* (16)	U Hlaing (pers. comm., 1999)
Mandalay—Mogok: *Byant Gyi, Htayen Sho, Pyin Pit* (1)	Kammerling et al. (1994b), Hughes (1997), U Nanda (pers. comm., 1997)
Shan—Lai Hka: *Wan Ying* (8); Langhko: *Wan Hat* (10); Yawnghwe: *Mong Hsauk* (11)	U Hlaing (pers. comm., 1999)
Russia	
Siberia—Aldan: *Emeldzhak, Katalakh*	Evseev (1994a), Smith and Smith (1995)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18), *Passara* (16); Kegalla: *Avissawella* (9); Nuwara Eliya: *Hatton* (15), *Kuruwitenna* (13), *Nawalapitiya* (29); Polonnaruwa: *Elahera, Kaluganga Valley* (8)	
Southern—Hambantota: *Ambalantota* (11); Kalutara: *Alutgama* (10), *Horana* (34); Matara: *Morawaka* (4); Monaragala: *Embilipitiya* (19), *Kataragama* (17), *Okkampitiya* (5); Ratnapura: *Balangoda* (2), *Eheliyagoda* (25), *Kalawana, Kiriella, Kuruwita, Nivitigala* (1), *Rakwana* (3)	
Tajikistan	
Turkistan—Khorugh: *Kukhilyal*	Kammerling et al. (1995e), Smith and Smith (1995)
Vietnam	
Yen Bai—Luc Yen (2)	Kane et al. (1991)

TOPAZ

◆ Africa	
Madagascar	Henn et al. (1999b)
Antananarivo—Ambatolampy (45)	A. Chikayama (pers. comm., 1999)
Antananarivo—Faratsiho (44)	
Fianarantsoa—Ambositra (16)	
Fianarantsoa—Ilakaka–Sakaraha (23)	Pezzotta (1999)
Mahajanga—Andriamena (46)	Pezzotta (1999)
Toamasina—Andilamena (37)	Pezzotta (1999)
Toliara—Mahabe (47)	
Namibia	
Karibib—Usakos: *Spitzkoppe* (2)	Menzies (1995), Cairncross et al. (1998)
Tanzania	
Arusha—Longido (9)	Dirlam et al. (1992)
Morogoro—Magogoni (28); Mvuha (30)	Dirlam et al. (1992)

Gem material/locality	Reference
Ruvuma—Tunduru: *Lumasulu, Muhuwesi River* (2)	H. Krupp (pers. comm., 1999)
Zimbabwe	
Mashonaland North—Mwami–Karoi (2)	Shmakin and Wedepohl (1999)
◆ Asia	
China	More new finds... (1996)
Guangdong	
Guangxi	
Xinjiang	
Yunnan—Gaoligongshan	
India	
Kerala—Trivandrum (9)	Menon et al. (1994), Rajesh-Chandran et al. (1996)
Orissa—Balangir (10)	Choudhuri and Guarchary (1993)
Orissa—Sambalpur: *Baghdapa* (5); Subarnapur: *Sonepur* (10)	S. Fernandes (pers. comm., 1999)
Kazakhstan	
Karagandin—Karaganda: *Akchatau*	Smith and Smith (1995)
Myanmar	
Mandalay—Mogok: *Sakangyi* (1)	Hughes (1997)
Pakistan	Blauwet et al. (1997)
Northern Areas—Baltistan: *Gone, Nyet Bruk* (3); Gilgit: *Buleche, Shengus* (2)	Menzies (1995)
Northwest Frontier—Katlang: *Ghundao Hill* (6)	Aboosally (1999)
Russia	
Middle Ural Mountains—Asbest: *Mursinka*	Evseev (1994a), Menzies (1995), Smith and Smith (1995), Kolesar (1997), Spiridonov (1998)
Southern Ural Mountains—Yushno-Uralsk: *Kochkarskoye*	V. Bukanov (pers. comm., 1999)
Transbaikalia—Krasna Chikoi: *Malkhan*	Evseev (1994a)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18), *Passara* (16); Kurunegala: *Kurunegala* (21); Matale: *Matale* (7), *Rattota* (27); Nuwara Eliya: *Hatton* (15), *Nawalapitiya* (29); Polonnaruwa: *Elahera* (8)	
Southern—Kalutara: *Horana* (34); Ratnapura: *Balangoda* (2), *Ratnapura* (1)	
Tajikistan	
Turkistan—Pamir Mountains: *Rangkul, near Murgab*	Skrigitil (1996), Spiridonov (1998)
Ukraine	
Volyns'ka—Vladimir-Volynskiy	Menzies (1995), Spiridonov (1998)
Zhytomyr—Zhytomyr: *Volodarsk-Volynskiy*	Evseev (1994b), Smith and Smith (1995)
◆ Australia	
New South Wales—New England Range (10)	Webb and Sutherland (1998)
Queensland—Mount Surprise (20)	F. L. Sutherland (pers. comm., 1999)
◆ North America	
Canada	
British Columbia—Atlin, Mount Foster	Wilson (1999)
United States	
California—Ramona: *Little Three*	Foord et al. (1989)
New Hampshire—Carroll, Coos	Sinkankas (1997)
◆ South America	
Brazil	
Espírito Santo—Santa Teresa (16)	Cassedanne and Alves (1994), Menzies (1995)
Minas Gerais—Caraí: *Mucaia* (22); Itaipé: *Lavra do Aziz* (22); Pavão: *Ariranha* (22)	Cassedanne and Alves (1994)
Minas Gerais—**Ouro Prêto**: *Boa Vista, Capão, Dom Bosco, Vermelhão* (38)	Menzies (1995), Sauer et al. (1996)

TOURMALINE

◆ Africa	
Kenya	Keller (1992)
Coast—Kwale (12), Mgama-Mindi (21)	
Coast—Voi: *John Saul, Kisoli, Yellow* (13)	Simonet (2000)
Rift Valley—Magadi (14); Narok: *Osarara* (15)	
Madagascar	Henn et al. (1999b)
Antananarivo—Betafo: *Anjanabonoina* (2)	Pezzotta (1996, 1999)
Antananarivo—Antsirabe (3); Sahatany Valley: *Antandrokomby, Antanetyilapa, Ibity* (3)	Lefevre and Thomas (1997), Pezzotta (1999)
Fianarantsoa—Ambatofinandrahana (28); Ambositra: *Valzoro* (16); Farafangana: *Isamara* (35); Vondrozo (20)	Pezzotta (1999)
Fianarantsoa—Fianarantsoa (51)	
Fianarantsoa—Ilakaka–Sakaraha (23)	Hänni (1999), Pezzotta (1999)
Toamasina—Ambatondrazaka (22); Mananara (39)	
Mozambique	Malango and Taupitz (1996)
Nampula—Alto Ligonha: *Muiane, Naipa* (1)	Henn and Bank (1997)
Nampula—Nacala (5)	Correia Neves (1987)
Namibia	
Karibib—Usakos: *Neu Schwaben, Usakos* (8)	Schneider and Seeger (1992), Johnson and Koivula (1997f), Beard (1999)
Nigeria	
Oyo—**Ogbomosho**	Johnson and Koivula (1998g), Schmetzer (1999a)
Plateau—Keffi	Kanis and Harding (1990)
Tanzania	
Arusha—Babati (23), Merelani (15), Tiriti (31)	Dirlam et al. (1992)
Arusha—Landanai: *Titus-Tsakiris* (32)	Keller (1992), Suleman et al. (1994)
Arusha—Lelatema: *Lengasti* (3)	Dirlam et al. (1992), Keller (1992)
Dodoma—Chenene Mountains: *Hombolo* (33)	Keller (1992)
Dodoma—Mpwapwa (5)	Dirlam et al. (1992)
Kilimanjaro—Same (17)	Dirlam et al. (1992)
Morogoro—Magogoni (28); Matombo: *Linai* (27); Mvuha (30)	Dirlam et al. (1992)
Ruvuma—Tunduru: *Muhuwesi River* (2)	Milisenda et al. (1997), H. Krupp (pers. comm., 1999)
Tanga—Daluni (34); Handeni: *Kwachaga* (7); Ngomeni (35)	Keller (1992)

The Usakos mine in Namibia is the source of these tourmalines (6.94–11.29 ct). Courtesy of James Alger Co.; photo by Robert Weldon.

Gem material/locality	Reference
Tanga—Kwamsisi (36)	Dirlam et al. (1992)
Tanga—Umba Valley: *Gerevi Hills, Ngombezi* (21)	Dirlam et al. (1992), Keller (1992), Suleman et al. (1994)
Zambia	
Central—**Kabwe**: *Jagoda* (13)	Milisenda et al. (2000)
Eastern—Chipata (6)	Mambwe and Sikatali (1994)
Eastern—**Lundazi**: *Aries, Kalungabeba* (2)	Kamona (1994), Mambwe and Sikatali (1994), Johnson et al. (1997), Milisenda et al. (2000)
Eastern—Nyimba: *Hofmeyer* (7)	Kamona (1994), Milisenda et al. (2000)
◆ Asia	
Afghanistan	Bowersox and Chamberlin (1995)
Konar—Dhray-Pech, Kantiwa, Mualevi, Paprowk, Tsotsum, Vora Desh	
Laghman—Korghal, Mawi, Nilaw-Kolum (3)	
China	
Yunnan—Gaoligongshan	More new finds... (1996)
India	
Jammu and Kashmir—Himachal Pradesh (65)	Mehta (1997)
Karnataka—Mysore (33)	S. Fernandes (pers. comm., 1999)
Madhya Pradesh—Deobhog: *Latapara, Mukhagura, Sarnabahal, Sendmuna* (19)	Jha et al. (1993)
Orissa—Bagdihi (24); Sambalpur: *Sonepur* (5)	S. Fernandes (pers. comm., 1999)
Myanmar	Hughes (1997)
Kayah—Hsataw (27)	U Hlaing (pers. comm., 1999)
Mandalay—Mogok (1)	Kammerling et al. (1994b)
Sagaing—Madaya (13)	U Hlaing (pers. comm., 1999)
Shan—Makmai (28), Mong Hsu (3), Mong Pan (10)	U Hlaing (pers. comm., 1999)
Nepal	Niedermayer (1992)
Bheri—Surketh (6)	
Gandaki—Langtang (1), Naje (2)	
Gandaki—Marsyangdi Valley: *Manang* (2)	Koivula et al. (1994d)
Kosi—Sankhuwasabha: *Hyakule, Pahkuwa* (4)	Bassett (1987)
Mechi—Taplejung: *Ikhabu* (4)	
Rapti—Jajarkot (7)	
Pakistan	Blauwet et al. (1997)
Northern Areas—Gilgit: *Buleche, Shengus, Stak Nala* (2)	Laurs et al. (1998)
Northwest Frontier—Chitral (1); Neelum Valley: *Dongar Nar* (9)	
Russia	
Middle Ural Mountains—Asbest: *Lipovka*	Smith and Smith (1995), Emlin (1996), Zagorskii and Peretyazhko (1996), Spiridonov (1998)
Transbaikalia—Krasna Chikoi: *Malkhan, Menzinska*	Godovikov and Bulgak (1993), Evseev (1994a), Smith and Smith (1995), Spiridonov (1998)
Transbaikalia—Pervomayskoye: *Zavitinskoye*	V. Bukanov (pers. comm., 1999)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18), *Passara* (16); Kegalla: *Avissawella* (9); Kurunegala: *Kurunegala* (21); Polonnaruwa: *Elahera, Kaluganga Valley* (8)	
Southern—Hambontota: *Ambalantota, Ridiyagama* (11); Kalutara: *Horana* (34); Matara: *Morawaka* (4); Monaragala: *Embilipitiya* (19), *Kochchipatana* (6), *Okkampitiya* (5); Ratnapura: *Balangoda* (2), *Eheliyagoda* (25), *Kiriella* (1), *Kuruwita* (1), *Rakwana* (3)	
Tajikistan	Zagorskii and Peretyazhko (1996)
Turkistan—Pamir Mountains: *Kukurt River, Rangkul*	Skrigitil (1996), Spiridonov (1998)
Turkistan—Horog: *Shakhdara River, Vezdara River*	
◆ North America	
United States	Sinkankas (1997)
California—Mesa Grande: *Himalaya*	Fisher et al. (1999)
California—Pala: *Stewart*	
Maine—Androscoggin: *Auburn*	Francis (1985)
Maine—Oxford: *Mount Apatite, Newry, Paris*	Francis (1985), Francis et al. (1993)
◆ South America	
Brazil	
Bahia—Brumado (30)	Cassedanne and Roditi (1996)
Bahia—Itamarati: *Lajedo* (1); Itambé: *Morro da Gloria* (24)	R. Wegner and O. Moura (pers. comm., 2000)
Ceará—Berilândia; Quixeramobim: *Condado* (39)	R. Wegner and O. Moura (pers. comm., 2000)
Minas Gerais—**Araçuaí–Jequitinhonha–Salinas–Virgem da Lapa:** *Baixa Grande, Barra de Salinas, Lavrinha, Manoel Mutuca, Morro Redondo, Ouro Fino, Pirineus, Salinas, Xanda* (18); **Malacacheta–Urupuca River–São José da Safira**: *Aricanga, Cruzeiro, Golconda, Santa Rosa* (19)	Cassedanne and Roditi (1996)
Minas Gerais—**Conselheiro Pena–Divino das Laranjeiras–Galiléia**: *Formiga, Itatiaia, Jonas, Pamaro, Sapo, Urucum* (8)	Cassedanne and Roditi (1996), Steger (1999)
Minas Gerais—Marambaia (22)	Proctor (1984)
Paraíba—Frei Martinho: *Alto Quixaba* (10)	Ferreira (1998)
Paraíba—Salgadinho: *São José da Batalha* (10)	Bank et al. (1990), Fritsch et al. (1990), Brandstätter and Niedermayr (1994), Cassedanne (1996), Laurs and Shigley (2000)
Rio Grande do Norte—Parelhas: *Alto da Cabeça, Bulandeira, Mulungu/Boqueirãozinho/Capoeira, Quintos* (10)	Karfunkel and Wegner (1996), Soares (1998), Laurs and Shigley (2000)
ZOISITE (Includes tanzanite)	
◆ Africa	
Tanzania	
Arusha—Mbuguni: *Merelani* (15)	Barot and Boehm (1992), Dirlam et al. (1992), Keller (1992), Suleman (1995), McDonald (1999), Wentzell (2000)
◆ Asia	
Pakistan	
Northern Areas—Skardu (3)	Koivula et al. (1992a)

This gem-quality tanzanite crystal from Merelani, Tanzania, measures 8.3 cm long. Courtesy of Pala International; photo by Jeff Scovil.

TABLE 2. Localities of the 1990s for less common gemstones.[a]

Gem material/locality	Reference
Apatite	
Brazil	R. Wegner and O. Moura (pers. comm., 2000)
Bahia—Itambé: *Bananeira* (24)	
Bahia—Jacobina: *Ibira* (2)	Koivula et al. (1993a)
Minas Gerais—Conselheiro Pena: *Aldeia* (8); Coroaci: *Golconda* (19)	
Paraíba—Pedra Lavrada: *Alto Feio* (10)	
India	S. Fernandes (pers. comm., 1999)
Karnataka—Mysore: *Katteri, Melkote* (33)	
Orissa—Kalahandi: *Banjipadar* (53)	
Tamil Nadu—Salem: *Kurumbapatti, Peryasoragai* (17)	
Kenya	
Eastern—Embu (2)	Barot et al. (1995)
Madagascar	
Antsiranana—Milanoa (13)	Kammerling et al. (1995a), Laurs (2000)
Toliara—Itrongay (43)	Pezzotta (1999)
Myanmar	
Mandalay—Mogok: *Kyaukpyatthat* (1)	Hughes (1997)
Russia	
Siberia—Lake Baikal: *Sludyanka*	Y. Shelementiev (pers. comm., 1999)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Kegalla: Kegalla (9); Kurunegala: *Kurunegala* (21); Matale: *Matale* (7), *Nalanda* (23)	
Southern—Matara: *Akuressa* (4), *Deniyaya* (31); Ratnapura: *Balangoda* (2), *Eheliyagoda* (25), *Rakwana* (3), *Ratnapura* (1)	
Benitoite	
United States	
California—New Idria: *Benitoite Gem*	Frazier and Frazier (1990a,b), Laurs et al. (1997)
Charoite	
Russia	
Siberia—Olekminsk: *Murun (Chara River)*	Konev et al. (1993), Evdokimov (1995)
Chrome Diopside	
Russia	
Yakutia (Sakha)—Aldan: *Inagli*	Gadiyatov (1996), Johnson and Koivula (1996e), Spiridonov (1998)
Feldspar	Frazier and Frazier (1993a)
Australia	
Northern Territory—Harts Range (3)	Brown and Bracewell (1984)
Brazil	
Minas Gerais—Santa Maria de Itabira (3)	Cassedanne (1994), Karfunkel and Chaves (1994)
Canada	
Labrador	B. Wilson (pers. comm., 1999)
Finland	
Lymi—Lappenranta: *Ylämaa*	Frazier and Frazier (1993b), Johnson and Koivula (1997a)
India	Current mining report... (1998), S. Fernandes (pers. comm., 1999)
Bihar—Kodarma (68)	
Bihar—Patna (67)	Johnson and Koivula (1997c)
Kerala—Travancore (69)	
Orissa	
Tamil Nadu—Kangayam–Karur: *Karattupalayam, Kodanthur, Madiakattupudur, Odanalli* (54)	Kammerling et al. (1995b)
Tamil Nadu—Madurai (7); Salem (17)	
Madagascar	Pezzotta (1999)
Antananarivo—Betafo: *Ambohimanambola, Anjanabonoina* (2); Faratsiho (44)	
Fianarantsoa—Ambositra (16)	
Mahajanga—Kandreho (41)	
Toamasina—Ambatondrazaka (22)	
Toliara—Itrongay (43)	Weiss (1991)
Toliara—Mahabe (47)	
Myanmar	
Mandalay—Mogok: *Kyatpyin*, *Kyaukpyatthat* (1)	Hughes (1997)
Russia	
Ural Mountains—Kasil-Kishtim: *Potaniha*	Ostroumov (1991)
Sri Lanka	
Central—Badulla: *Haputale*, *Koslanda* (18)	
Southern—Galle: *Ambalangoda*, *Mitiyagoda* (24); Ratnapura: *Balangoda* (2), *Ratnapura* (1)	Harder (1992, 1994), Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Tanzania	A. Suleman (pers. comm., 1999)
Dodoma—Kondoa (41)	
Kilimanjaro—Same (17)	
Rukwa—Sumbawanga (10)	
United States	Johnston et al. (1991)
Oregon—Harney: *Ponderosa*	
Oregon—Lake: *Plush*	Henn and Bank (1992)
Iolite (Cordierite)	
Brazil	R. Wegner and O. Moura (pers. comm., 2000)
Paraíba—Nova Palmeira (10)	
Rio Grande do Norte—Parelhas (10)	
Canada	
British Columbia—Selkirk Mountains: *Slocan Valley*	Johnson and Koivula (1999a), Wight (1999b)
India	S. Fernandes (pers. comm., 1999)
Karnataka—Tumkur (35)	
Orissa—Boudh: *Kantamal, Manmunda* (13); Kalahandi: *Orhabahal*, *Urharanga* (53); Nawapada: *Burhapara* (63)	
Tamil Nadu—Kangayam–Karur: *Bommagoundanur, Uthampatty* (54); Madurai (7)	
Madagascar	
Antananarivo—Sahatany Valley: *Ibity* (3)	Lefevre and Thomas (1997)
Toliara—Toliara (49)	Pezzotta (1999)
Myanmar	
Mandalay—Mogok (1)	Hughes (1997)
Russia	
Siberia—Altai Mountains	Y. Shelementiev (pers. comm., 1999)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Kegalla: *Avissawella* (9); Kurunegala: *Kurunegala* (21); Nuwara Eliya: *Hatton* (15); Polonnaruwa: *Elahera* (8)	
Southern—Monaragala: *Embilipitiya* (19); Ratnapura: *Ratnapura* (1)	
Lapis Lazuli	
Afghanistan	
Badakhshan—Kokcha Valley: *Sar-e-Sang* (6)	Bowersox and Chamberlin (1995)
Chile	
Andes Mountains—Ovalle: *Flor de Los Andes, San Marcelo, Seguridad* (1)	Ward (1996a), Coenraads and Canut de Bon (2000)
Myanmar	
Mandalay—Mogok: *Dattaw, Kabaing, Thapanbin* (1)	Kammerling et al. (1994b)
Russia	
Siberia—Lake Baikal: *Malobystrinkskoye*	Spiridonov (1998)
Tajikistan	
Turkistan—Pamir Mountains: *Lyadzhvardarinskoye*	Spiridonov (1998)

[a]*This chart includes key producing localities of the decade, with references to publications in the contemporary literature. The country name is followed by the province/state/region, then the district, and finally the mine/deposit/occurrence name (in italics). Numbers in parentheses refer to locations plotted on the regional maps. Some countries are not shown on these maps, and therefore do not have any numbers indicated.*

Gem material/locality	Reference
United States	
Colorado—Italian Mountain: *Blue Wrinkle*	Johnson and Koivula (1998c)
Maw Sit Sit	
Myanmar	
Kachin—Kansi: *Maw-sit* (15)	Colombo et al. (2000), Hughes et al. (2000)
Red Beryl	
United States	
Utah—Beaver: *Wah Wah Mountains*	Aurisicchio et al. (1990), Henn and Becker (1995)
Rhodochrosite	
Argentina	
Catamarca—Andalgalá: *Capillitas* (1)	Saadi and Grasso (1992), Cassedanne (1998)
United States	
Colorado—Park: *Sweet Home*	Knox and Lees (1997), Moore et al. (1998)
Rhodonite	
Canada	B. Wilson (pers. comm., 1999)
British Columbia	
Northwest Territories	
Russia	
Middle Ural Mountains—Ekaterinburg: *Kuaganovo*	Brusnitsyn and Serkov (1996)
Scapolite	
China	
Xinjiang—Kashi	More new finds... (1996)
Myanmar	
Mandalay—Mogok (1)	Couper (1991), Kammerling et al. (1994b), Hughes (1997)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Southern—Hambantota: *Ambalantota* (11); Kalutara: *Horana* (34); Matara: *Deniyaya* (31); Monaragala: *Embilipitiya* (19); Ratnapura: *Balangoda* (2), *Ratnapura* (1)	
Tajikistan	
Turkistan—Pamir Mountains: *Kurkurt, Rangkul*	Zolotarev (1993), Kammerling et al. (1995f), Skrigitil (1996)
Tanzania	
Dodoma—Dodoma (4)	Barot et al. (1995)
Sphene (Titanite)	
Australia	
Northern Territory—Harts Range (3)	McColl and Petersen (1990)
Canada	
Quebec—Chibougamau	Robinson and Wight (1997)
India	
Tamil Nadu—Karur: *Pattukaranur* (54)	S. Fernandes (pers. comm., 1999)
Madagascar	Pezzotta (1999)
Antsiranana—Daraina (48)	Johnson and Koivula (1998i), Laurs (2000)
Antsiranana—Milanoa (13)	
Myanmar	
Mandalay—Mogok (1)	Kammerling et al. (1994b), Hughes (1997)
Russia	
Ural Mountains—Perm: *Saranovskoe*	Hyrsl and Milisenda (1995), Kolesar (1997)
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Polonnaruwa: *Elahera* (8)	
Southern—Galle: *Galle* (12); Matara: *Akuressa*, *Morawaka* (4); Monaragala: *Kataragama* (17)	
Spodumene—Kunzite/Hiddenite	
Afghanistan	Bowersox and Chamberlin (1995)
Konar—Kantiwa, Vora Desh (2)	
Laghman—Mawi, Nilaw-Kolum (3)	
Brazil	Proctor (1984, 1985)
Minas Gerais—Galiléia: *Barra de Cuieté, Urucum* (8); Urupuca River: *Urupuca* (19)	
Minas Gerais—Conselheiro Pena: *Kunzita*, *Resplendor* (8)	
Madagascar	Henn et al. (1999b), Pezzotta (1999)
Antananarivo—Betafo (2), Ilakaka-Sakaraha (23)	
Antananarivo—Sahatany Valley: *Antsirabe* (3)	Lefevre and Thomas (1997)
Myanmar	
Mandalay—Mogok (1)	Hughes (1997)
Sri Lanka	
Southern—Monaragala: *Kataragama* (17)	Milisenda and Henn (1999)
United States	
California—Pala: *Stewart*	Sinkankas (1997)
Sugilite	
South Africa	
Cape—Hotazel: *Wessels* (7)	Shigley et al. (1987)
Turquoise	
China	
Hubei—Yungaisi	Liu (1999)
Iran	
Nischapur—Kuh-I-Binalud: *Maaden*	Gübelin (1999), Meister (1999)
Mexico	
Sonora—Cananea	Sinkankas (1997), Lieber (1999)
United States	Sinkankas (1997), Lieber (1999)
Arizona—Tucson: *Bisbee, Courtland, Lone Star, Morenci, Silver Bell, Sleeping Beauty, Turquoise Mountain*	
California—Mohave Desert: *Baker, Inyo Mountains*	
Colorado—Pueblo: *Cripple Creek, King's Manassa, Villa Brove*	
Nevada—Battle Mountain: *Austin, Cortez, Tenabo;* Tonopah: *Dusty Tim, Lone Mountain, Monte Cristo, Montezuma, Royal Blue*	
New Mexico—Alamagordo: *Jarilla*, *Lost Mine*; Cerillos: *Chaco Canyon, Mount Chalchihuitl, Turquoise Hill*; Silver City: *Burro Mountains, Little Hatchet Mountain*	
Zircon	
Australia	
New South Wales—New England Range (10)	F. L. Sutherland (pers. comm., 1999)
Northern Territory—Harts Range (3)	Faulkner and Shigley (1989)
Queensland—Anakie-Rubyvale (31)	F. L. Sutherland (pers. comm., 1999)
Cambodia	
Battamberg—Pailin (1)	Hughes (1997)
Madagascar	Pezzotta (1999)
Antananarivo—Antanifotsy (10)	
Fianarantsoa—Fianarantsoa (51)	
Fianarantsoa—Ilakaka-Sakaraha (23)	Hänni (1999), Henn et al. (1999b)
Toliara—Amboasary (14), Betroka (27)	
Myanmar	
Mandalay—Mogok (1)	Hlaing (1990a), Hughes (1997)
Nigeria	
Kaduna—Jemma	C. Arps (pers. comm., 1999)
Russia	Y. Shelementiev (pers. comm., 1999)
Far East—Primorskiy Krai	
Southern Ural Mountains—Chelyabinsk: *Ilmen Mountains* and *Vishnevie*	
Sri Lanka	Dissanayake and Rupasinghe (1993), Milisenda and Henn (1999)
Central—Badulla: *Haputale* (18), *Passara* (16); Kegalla: *Avissawella* (9); Nuwara Eliya: *Hatton* (15), *Nuwara Eliya* (22); Polonnaruwa: *Elahera* (8)	
Southern—Kalutara: *Alutgama* (10); Matara: *Akuressa*, *Morawaka* (4); Monaragala: *Embilipitiya* (19); Ratnapura: *Balangoda* (2), *Pelmadulla* (1), *Rakwana* (3), *Ratnapura* (1)	
Tanzania	
Kilimanjaro—Same (17)	A. Suleman (pers. comm., 1999)
Ruvuma—Tunduru: *Muhuwesi River* (2)	H. Krupp (pers. comm., 1999)

TABLE 3. Localities for cultured and natural pearls.[a]

Country / Area / Body of water	Mollusk	Predominant pearl color	Reference
Australia			
New South Wales	*Pinctada maxima* (White-lipped oyster, gold-lipped oyster)	White, "cream," "silver," "golden"	Muller (1999), A. Muller (pers. comm., 2000)
Northern Territory			Van Zuylen (1993), N. Paspaley (pers. comm., 2000)
Queensland			Doubilet (1991); A. Muller, N. Paspaley (pers. comm., 2000)
Western Australia			N. Paspaley (pers. comm., 2000)
Western Australia	*P. albina* (Arafura pearl oyster)	White	A. Muller (pers. comm., 2000)
Canada			
British Columbia	*Haliotis kamtschatkana* (Pinto abalone)	Green to blue, purple, red	Shirai (1994), Fankboner (1995), Wentzell (1998), Koethe and Bell (1999)
China—Freshwater			
Anhui, Hubei, Jiangxi	*Cristaria plicata* (River shell, wrinkle shell), *Hyriopsis cumingi* (Triangle shell)	White, "cream," yellow, orange, pink, purple, green	Pearl production in China…(1997), A. Muller (pers. comm., 2000), Tao (2000)
Guangdong	*H. cumingi*		Prices stable after years…(1998)
Guangxi	*H. cumingi, H. schlegi* (Biwa pearly mussel)		Peach (1999), A. Muller (pers. comm., 2000), Scarratt et al. (2000)
Jiangsu	*C. plicata, H. cumingi*		Sin (1993), Pearl production in China…(1997), Sheung (1999), A. Muller (pers. comm., 2000)
Zhejiang	*H. cumingi, H. schlegi*	White, "cream," yellow, orange, pink, purple, green	Sheung (1999), A. Muller (pers. comm., 2000), Tao (2000)
China—Saltwater			
Guangdong (including Hainan Island)	*P. Fucata* (Chinese Akoya oyster)	White, "cream," yellow, pink, blue	Chinese Akoya industry...(1999)
Guangxi			Akamatsu (1999), Chinese Akoya industry...(1999), Tao (2000)
Zhejiang	*P. maxima*	White, "cream"	Tao (2000)
Cook Islands[b]	*P. maculata* (Maculated pearl oyster)	Black, gray, blue to green	Buscher (1999)
	P. margaritifera (Black-lipped oyster)		Sims and Fassler (1994), Buscher (1999)
	P. maxima	White, "cream," "silver," "golden"	Sims and Fassler (1994)
French Polynesia			
Gambier	*P. margaritifera*, var. *cumingi* (Black-lipped oyster)	Black, gray, brown, blue to green, purple, yellowish green	R. Wan (pers. comm., 2000)
Society Islands			A. Muller (pers. comm., 2000)
Tuamotu Archipelago[b] (numerous islands)			Goebel and Dirlam (1989); R. Wan (pers. comm., 1999); S. Assael, M. Coeroli, A. Muller, C. Rosenthal (pers. comm., 2000)

The Chinese freshwater cultured pearls in this necklace and earrings measure approximately 8–9 mm long. Courtesy of Frank Mastoloni Sons; photo by Maha Tannous.

Australia became an important source of South Sea cultured pearls during the 1990s. The cultured pearls in these earrings (above) are from the north coast of Australia and measure 12 mm in diameter. Designed and manufactured by the Stirrups Collection/Paspaley Pearls.

Country / Area / Body of water	Mollusk	Predominant pearl color	Reference
Indonesia			
Maluku (several islands)	*P. maxima*	"Golden," white, "cream," "silver"	Johnson and Koivula (1997d), Muller (1999), A. Muller (pers. comm., 2000)
Sulawesi, Sumatra, Sumbawa			Muller (1999), A. Muller (pers. comm., 2000)
Japan—Freshwater			
Lake Biwa	*H. schlegeli*	White, "cream," pink, "silver," brown, orange, gray, blue	Shirai (1994)
Lake Kasumiga	*H. cumingi–H. schlegeli* hybrid	White, "cream," lavender, pink	C. Gregory (pers. comm., 2000)
Japan—Saltwater			Akamatsu (1999)
Ehime	*P. fucata martensii* (Akoya oyster)	White, "cream," yellow, gray, blue	A. Muller (pers. comm., 2000)
Mie (includes Ago Bay)			Shirai (1994), S. Akamatsu (pers. comm., 1999), A. Muller (pers. comm., 2000)
Nansei Shoto (several islands)	*P. margaritifera*	Black, gray, brown, blue to green, purple, yellowish green, white	A. Muller (pers. comm., 2000)
	P. maxima	White, "cream," "golden," "silver"	A. Muller (pers. comm., 2000)
Mexico			
Baja California[b]	*Pteria sterna* (Western winged pearl oyster)	Black, gray, "silver," blue to green	Hurwit (2000)
Baja California[b]	*P. mazatlanica* (Panamanian pearl oyster)	Black, gray, "silver," blue to green	Crowningshield (1991), Cariño and Monteforte (1995)
Guyamas			M. Goebel (pers. comm., 2000)
Myanmar	*P. maxima*	"Golden," white, "cream," "silver"	Tun (1999),Themelis (2000)
New Zealand			
Stewart Island	*Haliotis iris* (Paua, iris, or rainbow abalone)	Green to blue, purple, red	Wentzell (1998), McKenzie (1999)
North America			
Pacific Coast	*H. rufescens* (Red abalone), *H. fulgens* (Green abalone)	Green to blue, purple, red	Hurwit (1993, 1994), Fankboner (1995), Koethe and Bell (1999)
Philippines			Muller (1999)
Mindanao	*P. maxima*	"Golden," white, "cream"	Shirai (1994)
Palawan, Surgao Strait			D. Fiske (pers. comm., 1999)
Visayan Islands			Doumenge et al (1991)
South Africa	*Haliotis*	Green to blue, purple, red	Fankboner (1995)
United States—Freshwater			
Tennessee	*Megalonaias nervosa* (Washboard mussel	White, gray, "silver," with "rose" or blue overtone	Latendresse (1999)
United States—Saltwater			
Hawaii[b]	*P. margaritifera*	Black, gray, "silver," blue to green	Walther (1997)
Vietnam—Freshwater	*C. plicata*	White, "cream," pink	Bosshart et al. (1993)
Vietnam—Saltwater	*P. fucata*	White, "cream," yellow, pink,	Vietnam produces Akoya (1999)

[a]*A more detailed version of this table is available at the* Gems & Gemology *data depository on the Web site www.gia.edu/gandg.*
[b]*Indicates areas that reemerged in the 1990s after declining earlier in the 20th century due to overharvesting and/or environmental degradation.*

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Additional information (sometimes in the form of yearly country-by-country production data) can be found in sources such as:

1. The gemstone chapter of the Bureau of Mines *Minerals Yearbook*, published annually by the U.S. Department of the Interior.
2. *Mining Annual Review*, published by the Mining Journal, London.
3. For diamond information, *Proceedings of the Kimberlite Conference*, published quadrennially in the country where the conference is held.
4. *Proceedings of the International Gemmological Conference*, published every two years in the country where the conference is held.

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