SAPPHIRES FROM THAMMANNAWA, KATARAGAMA AREA, SRI LANKA

Pannipitiye G. R. Dharmaratne, H. M. Ranjith Premasiri, and Dayananda Dillimuni

The February 2012 discovery of high-quality blue sapphires at Thammannawa near Kataragama in southeastern Sri Lanka has intensified gem mining and exploration in the surrounding area and all over the country. The deposit is hosted by the Kataragama klippe, and corundum mineralization is associated with pegmatitic intrusions and surrounding micaceous layers. Well-formed crystals from this primary deposit display flat faces and sharp edges with an unusually vitreous luster. The sapphires possess good transparency and a pure blue color that is characteristic of corundum from this deposit. Several kilograms of rough material have been produced so far, with some crystals larger than 200 g. Faceted blue sapphires of fine color and weighing more than 20 ct have been cut.

In February 2012, fine blue sapphires (e.g., figure 1) were discovered during the reconstruction of a two-lane road from the Lunugamwehera area to Kataragama in southeastern Sri Lanka (figure 2). Gravel for the roadbed was supplied from nearby land belonging to the Forest Conservation Department (FCD). After several days of work, a truck driver noticed glittery reflections in material that had been dumped the previous day. The driver quickly recognized the crystals as blue sapphires and filled a sack with them. He abandoned the truck and left a note for the vehicle's owner pointing him to a parcel of the gems in the battery box. Local farmers noticed the abandoned truck and soon found their own gems in the roadbed. As the news spread, thousands rushed to the site and hauled away bags full of the newly laid gravel and soil (figure 3). This lasted a day or two until the area was secured by police, the armed forces, and the National Gem & Jewellery Authority (or NGJA, the agency responsible for gems found on federal lands). By February 23, newspapers and TV stations were reporting the discovery (Fernando, 2012; Nizam, 2012).

Figure 1. This sapphire from the new Thammannawa deposit weighs 20.5 ct. Courtesy of Ajward Deen; photo by P.G.R. Dharmaratne.

While the road itself was being guarded, one enterprising individual thought to search for the original source of the gravel. This turned out to be only 1 km away, on the side of the same road, at a place called

See end of article for About the Authors and Acknowledgments.
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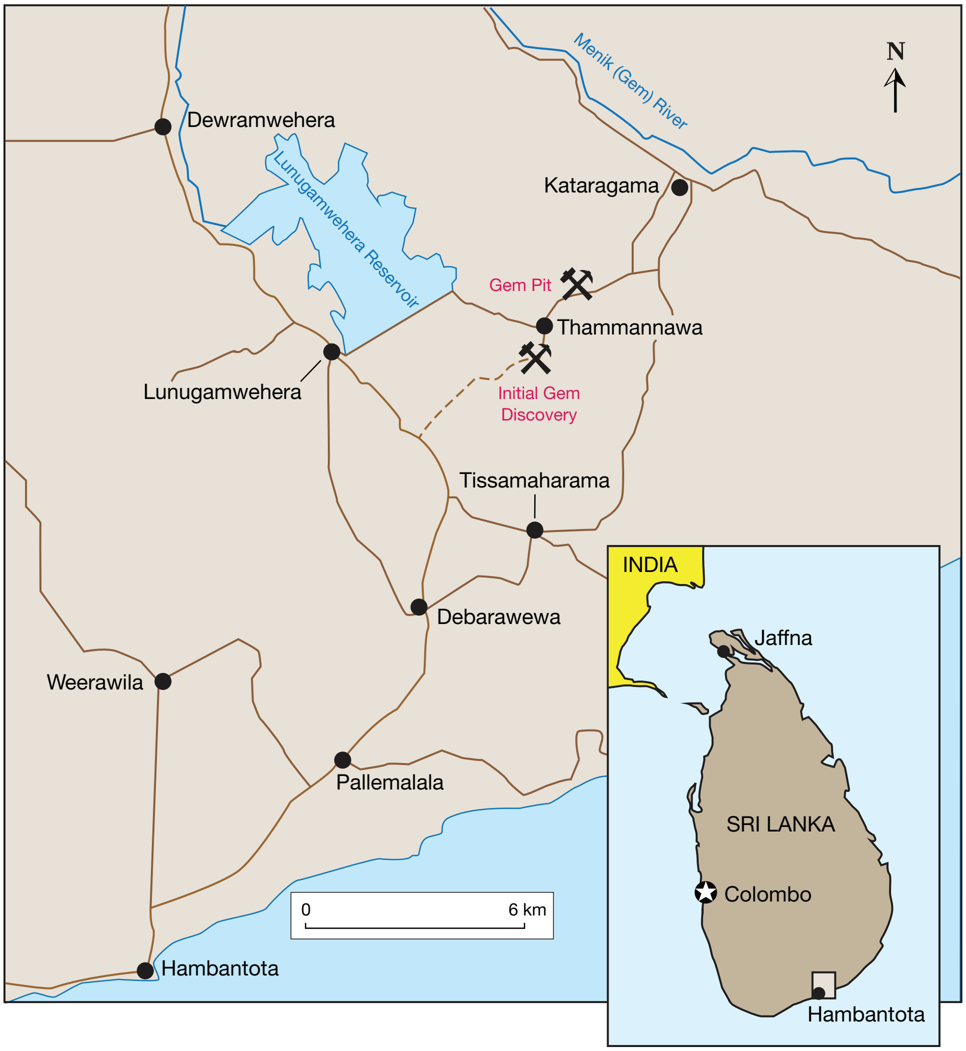

Figure 2. The Thammannawa deposit is located along the road from the Lunugamwehera area to Kataragama in southeastern Sri Lanka.

Thammannawa. Once again, thousands rushed to the scene in search of sapphires (figure 4), and some even used excavators and dump trucks to remove loads of earth. However, the NGJA soon secured this area as well. The entire excavated area measured only about 60 m^2. The NGJA and FCD divided this pit and the surrounding area into 49 blocks of about 10 perches (22 m^2) each. Mining rights for these blocks went up for public auction on February 24.

On February 27, these authors were permitted to study the new sapphire deposit with special permission, accompanied by a police escort. We were advised not to pick up anything, as the mining rights were privately owned. We also visited the road construction site where the gems were first discovered, which was still under heavy guard.

LOCATION AND ACCESS

The Thammannawa corundum deposit is located ~245 km from the capital city of Colombo at 6°22′14.08″N and 81°17′19.04″E. This falls on the southern boundary of the Monaragala District in Uva Province. The site is accessible by a gravel road and lies 4 km from the historical pilgrimage town of Kataragama (again, see figure 2). This road, which extends ~12 km from the Lunugamwehera area to Kataragama via Thammannawa, is being paved with asphalt.

Southeastern Sri Lanka is covered by low, dense dry-zone forest and shrubs. The mining site is situated within a forest and there are few settlements. Local inhabitants rely on the land for seasonal agriculture.

Figure 3. During the initial gem rush at the road construction site, people removed the gravel and soil in bags and dump trucks. Photo by Eranga Basnayake.

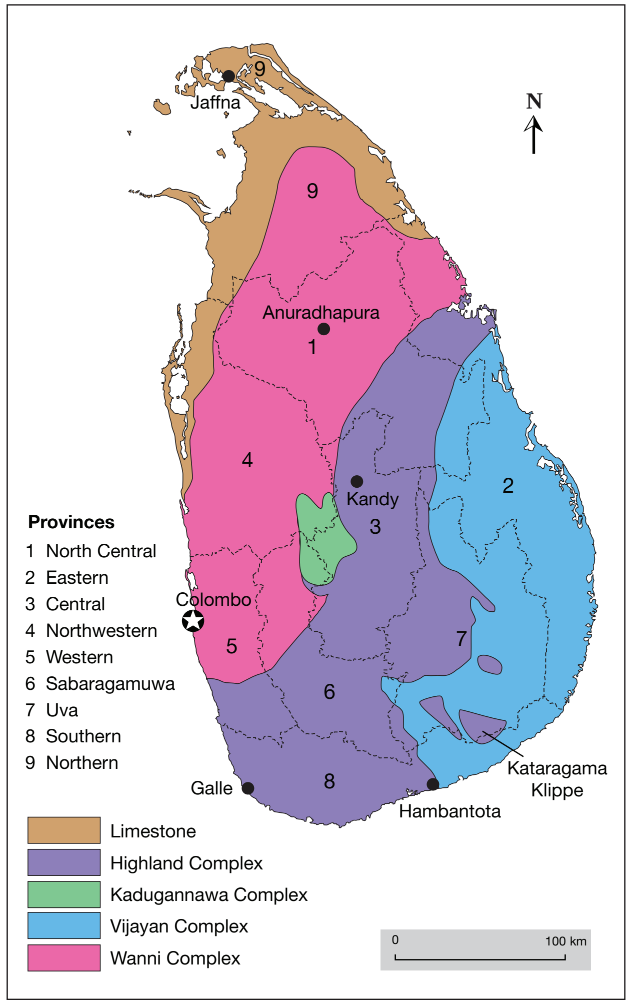

Figure 5. This simplified geologic map of Sri Lanka shows the location of the Kataragama klippe, one of the largest portions of the Highland Complex within the Vijayan Complex. Adapted from Cooray (1994).

GEOLOGY

Regional Setting. Sri Lanka is mainly underlain by high-grade metamorphic rocks of Proterozoic age (figure 5). These rocks have been subdivided into three principal metamorphic complexes based on their age and tectonic setting (Kroner et al., 1991): the Highland Complex (granulite facies) and the Vijayan and Wanni Complexes (both upper amphibolite facies). The new sapphire discovery is hosted by rocks of the Highland Complex within the Kataragama klippe metamorphic complex (Silva et al., 1981).

Figure 4. The source of the gravel used at the road construction project proved to be this quarry, which was the scene of a second gem rush. Photo by Eranga Basnayake.

Rocks of the Highland Complex have been subjected to multiple events of deformation and metamorphism. The age of the original metasediments is inferred to be ~2 billion years (Ga), with subsequent metamorphism and granitoid emplacement occurring 1,942–665 million years ago (Ma). Peak (granulite-grade) metamorphism took place during 665–550 Ma, resulting in the formation of charnockitic rocks (Milisenda et al., 1988; Holzl et al., 1991). Therefore, Highland Complex rocks are generally considered to span an age range of 0.67–2 Ga.

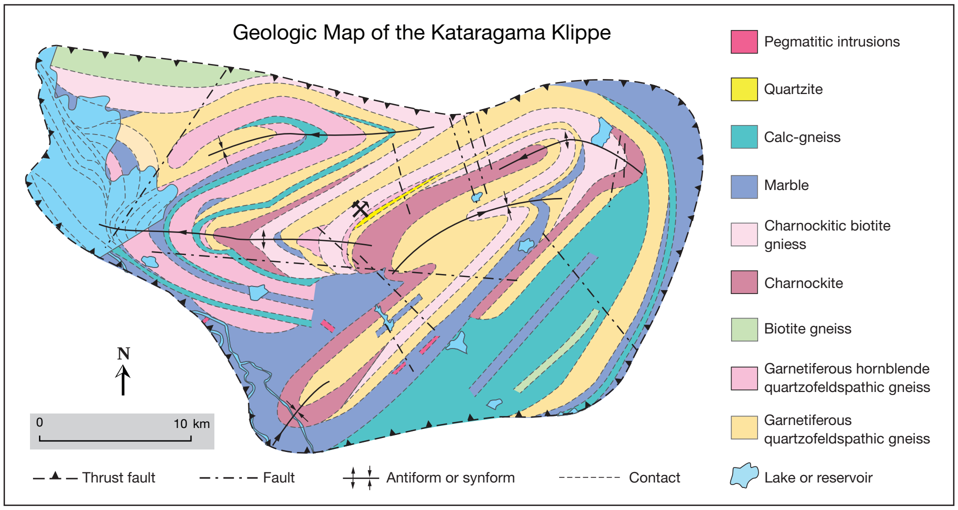

Figure 6. This geologic map of Kataragama klippe shows the new sapphire deposit is located within a band of charnockitic biotite gneiss. Source: Geological Survey and Mines Bureau (1997).

They have a layered appearance (ranging from millimeters to tens of meters wide) that is parallel to the main foliation of the rocks formed during the latest stage of pervasive metamorphism. The Kataragama area shows a series of large-scale antiform and synform structures trending east-west and northeast-southwest, and the klippe is separated from the surrounding Vijayan Complex rocks by thrust faults (figure 6).

In Brief

- A gem rush occurred in February 2012 after sapphires were discovered in a road construction site near Kataragama in southeastern Sri Lanka.
- Mining rights were auctioned on February 24 for 49 blocks covering the area.
- The sapphires are hosted by weathered pegmatitic intrusions associated with micaceous layers.
- Several kilograms of rough have been recovered, including lustrous well-formed crystals with transparent areas large enough to facet fine blue sapphires weighing more than 20 ct.

The major rock types in the Kataragama klippe are garnetiferous quartzofeldspathic gneiss ± hornblende, marble, calc-gneiss, charnockite and charnockitic biotite gneiss, and minor bands of quartzite (again, see figure 6). Late granitoid and pegmatitic intrusions of various sizes are locally found in the granulite-grade terrain; some crosscut the main geological structures, while others are parallel to the foliation of the host rocks.

Corundum Occurrence. Our field observations of the sapphire occurrence at Thammannawa revealed a complex, highly deformed geologic setting. The foliation of the rocks varies in several directions locally, but the general trend is 060°, dipping 50–60° northwest. Pegmatitic intrusions (figure 7) consisting of coarse-grained feldspar (kaolinized) and mica were surrounded by a micaceous layer that was foliated parallel to the contact with the intrusions. Quartz was absent from these rocks, though secondary silica formations such as chert and flint were seen in the area. Corundum mineralization was associated with the pegmatitic intrusions and mica layers, as indicated by our observations of a few small blue sapphire

Figure 7. Pegmatitic intrusions with associated micaceous layers host the corundum mineralization at Thammannawa. A Brunton compass (~7 cm wide) is shown for scale. Photo by H. M. R. Premasiri.

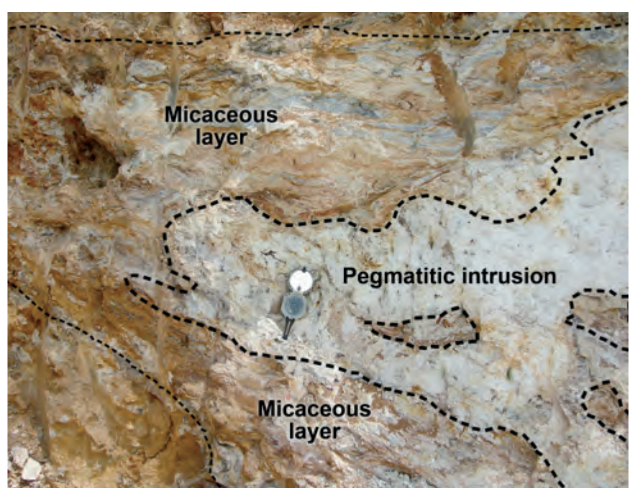

Figure 8. The known area of corundum mineralization (roughly outlined by dashed lines) is worked by backhoes in this view of the Thammannawa deposit. Photo by H. M. R. Premasiri.

crystals *in situ* and descriptions of the occurrence by local miners. This is also consistent with previous studies of Sri Lankan corundum mineralization, which have documented large crystals embedded in a feldspar matrix in the presence of biotite (Coomaraswamy, 1903; Hapuarachchi, 1989; Fernando et al., 2001; Hofmeister, 2001). Also present at Thammannawa were green tourmaline and garnet. The zone of intrusions and associated micaceous bands extended in the general foliation direction of the host rocks, and measured about 60 m thick.

Field geological evidence suggests that these rocks formed by a metasomatic process between pegmatitic fluid and the host rock. The corundum-bearing mineral assemblage is indicative of activity by pegmatitic fluid (e.g., Popov et al., 2007), and points to a metasomatic process for the origin of large euhedral sapphire crystals. Other than corundum, no noteworthy crystals or gem-quality minerals are known from the area.

MINING ACTIVITIES AND REGULATIONS

Gem mining in Sri Lanka has always been conducted by artisanal methods, using hand tools and water pumps. This tradition continues, and is supported by government and industry authorities to help insure the sustainability of gem mining activities and minimize damage to the environment. The use of backhoes and gravel-washing plants has been limited to isolated cases where the gravel beds were known to contain only low concentrations of gems or the same plot of land was worked by hand methods for many years. Therefore, the mining of secondary deposits (alluvial gem-bearing gravel layers) has continued in Sri Lanka for centuries. The less common primary gem deposits (*in situ*, often in weathered rocks) are commonly exhausted relatively quickly, and their discovery typically initiates gem rushes in which people dig with whatever equipment is available.

In Sri Lanka, gems found on private holdings or on government-owned land (forests, wildlife reserves, etc.) are considered de facto government property. In the case of private land, mining rights are given to the land owner and the government collects license fees in lieu of a royalty. However, in a gem rush situation the government imposes no immediate restriction, whether the land is private or government-owned. Invariably, though, the NGJA takes over the land and ensures it is kept under armed protection until the mining rights are auctioned to the public.

This same scenario unfolded at Thammannawa. The new deposit generated considerable excitement since the gems occurred as sharp-edged, well-formed crystals with a vitreous luster that is unprecedented in Sri Lankan sapphires. Because of the extraordinary publicity surrounding these gems, there was a frenzy of bidding at the auction for one-year mining rights. The auction raised a staggering 270 million rupees (US\$2.45 million), or an average of US\$18/m^2. However, some of the claims sold for as much as US\$80/m^2, the highest price per square meter in the auction of gem mining rights during the NGJA's 40-year existence.

After the auction, the use of backhoes and dump trucks was allowed to resume (figure 8). Many of the miners continue to dig pits in their allocated land, but some abandoned their claims after encountering hard rock. The production of gems from the deposit is difficult to assess because the miners almost always keep their discoveries secret. According to some government officials, the total value of sapphires found at the road construction site and in the pit before the auction could have approached US\$100 million.

In recent decades, successive administrations have introduced income tax concessions on rough gem sales to make trading more transparent. Only

Figure 9. These sapphire crystals and fragments (2.04–8.52 g) form some of the study samples used in this report. Courtesy of Udara Vijayamuni Zoysa; photo by D. Dillimuni.

about 2.5% of rough sales revenue is collected by the government as tax, whereas the tax applied to other businesses is often as high as 30%. Yet only a few gems—perhaps less than 10 specimens valued at over US$500,000 apiece—have been officially exported throughout the entire history of Sri Lanka, even though many gems over $1 million in value are discovered each year.

MATERIALS AND METHODS

Twenty-two sapphire crystals (2.0–289.6 g) and 11 faceted stones (1.00–6.48 ct) were studied for this report. According to the owners, the crystals were not heat treated, and our microscopic examination of the faceted stones showed no indications of heating. The samples were blue except for two yellow crystals; all were of good gem quality. Some were obtained at the site and others were received at the Allied Gemmological Institute & Laboratory for testing. The latter stones were loaned by the owner of the mining rights to block 6 (Udara Vijayamuni Zoysa), and by a reputable gem dealer in Ratnapura (Punsiri Tennekoon) who said they were from the Thammannawa deposit.

All 11 faceted sapphires were tested using a Topcon refractometer with a monochromatic filter. Specific gravity was determined hydrostatically on these same samples. Eighteen crystals and the 11 faceted stones were tested with both calcite and London dichroscopes and with prism- and diffraction-type hand spectroscopes. All rough and cut stones were checked for fluorescence with a standard UV lamp.

RESULTS

Visual Appearance. The study samples consisted of well-formed crystals or broken pieces of sapphire displaying bipyramidal or short barrel habits, mainly with a combination of hexagonal bipyramids and the

Figure 10. Weighing 4.5 g, this medium blue sapphire crystal displays a combination of hexagonal bipyramids with rhombohedral and basal pinacoids. Photo by Janaka Hemachandra.

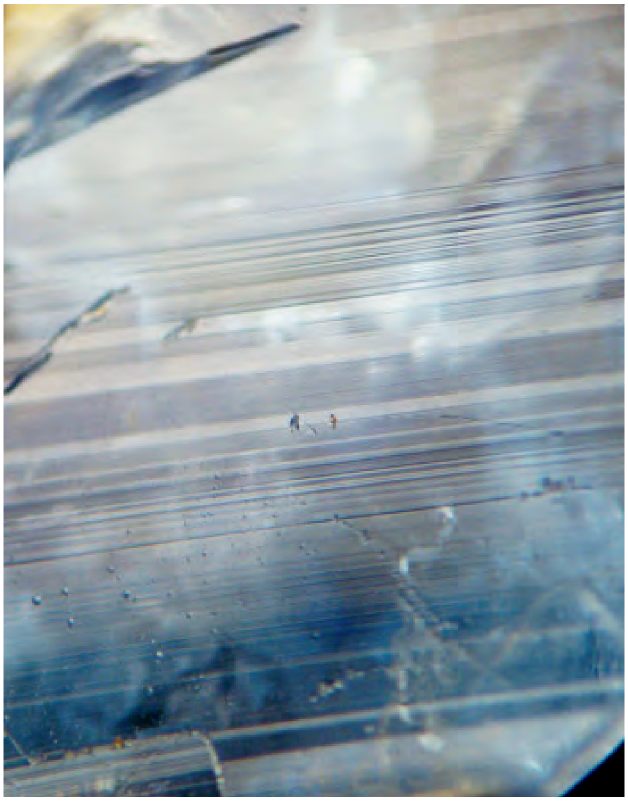

Figure 11. Thammannawa sapphire crystals show clearly defined horizontal striations on their bipyramidal faces. Photomicrograph by D. Dillimuni; magnified 10×.

basal pinacoid (figures 9 and 10). A few also showed rhombohedral and trigonal bipyramidal faces. Significantly, all of the crystals displayed lustrous crystal faces and perfectly sharp edges, with almost no signs of wear. Horizontal striations on bipyramidal faces were well defined (figure 11). When basal pinacoid faces were present, they displayed trigonal growth lines that evolved into hexagonal steps.

The samples were transparent with a glassy appearance, except for the largest specimen (~10 cm long), which was very dark blue and almost opaque. All the sapphire crystals displayed a strong pure blue color, somewhat different from the violetish blue commonly seen in Sri Lankan blue sapphire (figure 12). The crystals and cut stones also showed obvious dichroism, with a well-defined greenish blue seen perpendicular to the c-axis (figure 13). Observation with the dichroscope revealed that all the faceted samples had their table facet oriented perpendicular to the c-axis. Color zoning was clearly displayed in some crystals, parallel to the basal plane or the hexagonal pyramids. The color distribution in the faceted stones appeared even when viewed face-up, but closer examination revealed some irregular color patches with no particular orientation relative to the crystal structure.

Figure 12. These untreated sapphires (3.98–6.48 ct) show the pure blue color that is typical of stones from the Thammannawa deposit. Courtesy of Punsiri Tennekoon; photo by P. G. R. Dharmaratne.

Some of the crystals showed silky patches, but no asterism has been seen in sapphires from this area. Liquid-filled feathers, surface-reaching fractures, and large negative crystals were commonly visible to the unaided eye. Brown impurities in the fractures of some samples probably consisted of iron oxides/hydroxides.

Gemological Properties. Table 1 summarizes the properties of our Thammannawa samples and compares them to typical sapphires from elsewhere in Sri

Figure 13. Strong dichroism is observed with the London dichroscope in this 5.7 g sapphire. Photo by D. Dillimuni.

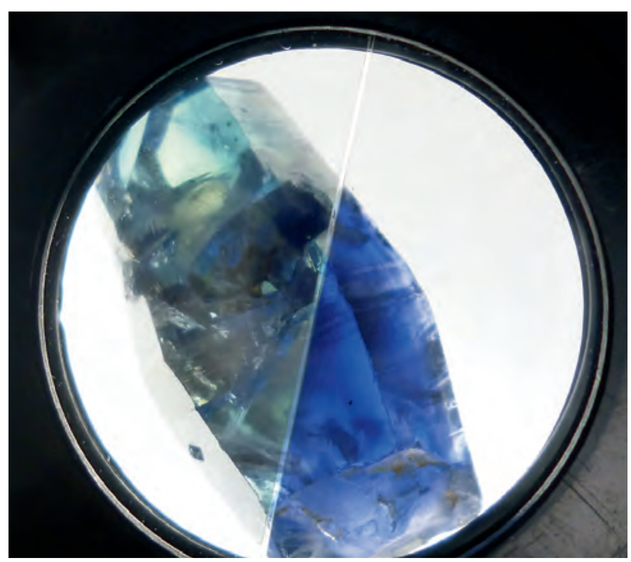

TABLE 1. Gemological properties of blue sapphires from Thammannawa and elsewhere in Sri Lanka.

Property	Thammannawa	Typical Sri Lanka
Color	Pure blue	Violetish blue
Color zoning	Straight and sharp zones parallel to the basal plane or hexagonal pyramid	Strong color zoning is common, but is less distinct in heat-treated stones. Some *(ottu)* have a colorless core with an outer layer or patch of blue color (Gunaratne, 1981; Hughes, 1997).
Optical phenomena	None	Asterism may be present
Refractive Indices	n_o = 1.760–1.762 and n_e = 1.768–1.770	n_o = 1.759–1.763 and n_e = 1.767–1.771
Birefringence	0.008	0.008
Specific Gravity	3.98–4.02[a]	3.98–4.02
Dichroism	Strong, in blue and greenish blue	Strong, in blue and greenish blue
Fluorescence		
Long-wave	Weak red (and strong orange from decomposed brown impurities in some crystals); colorless zones fluoresced weak orange	Inert to strong red to orange
Short-wave	Inert	Heat-treated specimens often show a zoned chalky blue-green reaction
Absorption spectra	Strong Fe absorption line at 450 nm	Weak to moderate Fe absorption line at 450 nm (Hughes, 1997)
Internal features	Short rutile needles, liquid-filled feathers, and negative crystals. Long rutile needles, translucent milky patches *(geuda)*, blue patches or zones *(ottu)*, and silk were not observed in any of the samples.	Short and long rutile needles, liquid-filled feathers, and negative crystals, translucent milky patches *(geuda)*, blue patches or zones *(ottu)*, and silk in asteriated samples

[a] *Crystals with large negative crystals had low SG values (~3.98), while all the faceted stones had a constant value of 4.00.*

Lanka. Microscopic examination showed that oriented short needles (probably rutile) are characteristic of the Thammannawa sapphires (figure 14). These inclusions formed weak silky patches in some samples, while others had needles that were more compact and coarse. In one case, part of a faceted stone showed a copper color with a metallic sheen due to a high concentration of these needles (figure 15). Liquid-filled

Figure 14. Fine rutile needles oriented in parallel layers form characteristic inclusions in the sapphires. Photomicrograph by D. Dillimuni; magnified 15×.

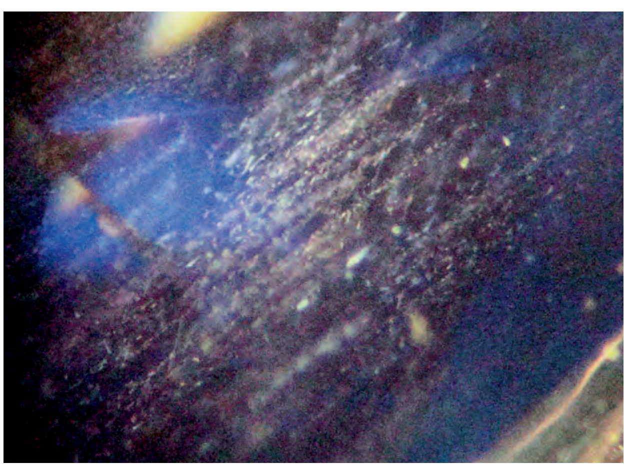

Figure 15. A portion of this sapphire contains a high concentration of rutile needles that produces a copper-colored metallic sheen. Photomicrograph by D. Dillimuni; magnified 20×.

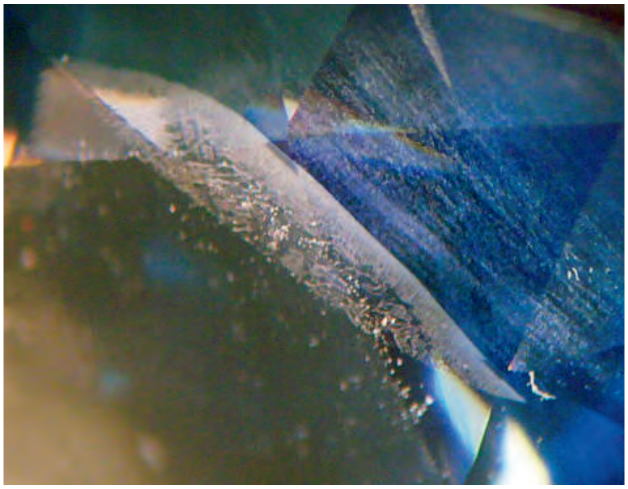

Figure 16. Liquid-filled feathers are common in the Thammannawa sapphires. Photomicrograph by D. Dillimuni; magnified 10×.

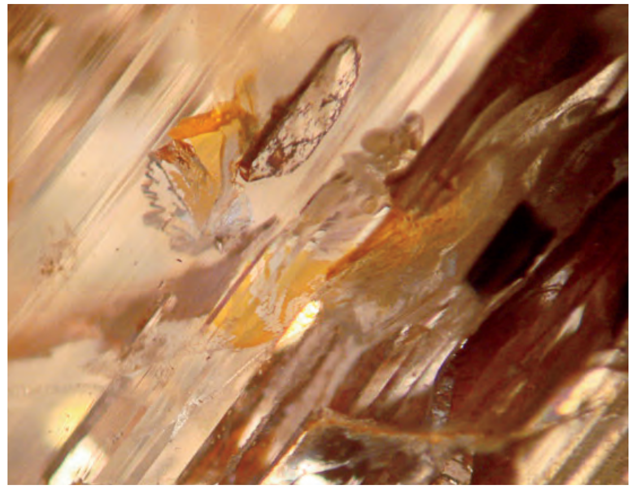

Figure 17. This yellow sapphire from Thammannawa contains a parallel arrangement of tabular negative crystals. Photomicrograph by D. Dillimuni; magnified 10×.

feathers were routinely observed in the sapphires from this deposit (figure 16). They were visible even in the rough specimens, on account of their smooth crystal faces. Negative crystals with tabular and columnar forms were also present as large isolated inclusions or grouped in parallel arrangement (figure 17).

DISCUSSION

Compared to other gem occurrences in Sri Lanka, the new deposit at Thammannawa has some characteristic features. Whereas other deposits on the island contain several gem varieties, only corundum has been found at this new locality—mainly blue and a few yellow sapphires. Star varieties, *geuda*, and corundum of other colors have not been found in this deposit. The crystals possess a bright vitreous luster and good transparency, with a glassy appearance; their sharp edges and lack of alluvial transport are unusual for Sri Lankan corundum. Also, their characteristically pure blue color is different from the violetish blue typically observed in sapphires from other parts of the country. Some of the stones displayed color zoning, but none showed the typical patches or concentrations of color that are amenable to heat treatment.

Although an absorption line at 450 nm is weak to moderate in typical Sri Lankan blue sapphires (Hughes, 1997), a strong line was observed in the Thammannawa specimens with both the prism and diffraction-type spectroscopes. UV-Vis-NIR spectra of Thammannawa sapphires obtained by Pardieu et al. (2012) confirmed the presence of this absorption line.

Consistent with their strong blue bodycolor, the samples exhibited a weak red fluorescence to long-wave UV radiation, an effect seen in some violet-blue sapphires from elsewhere in the country. The inclusions are also fairly characteristic to these stones: Short and fine rutile needles concentrated in layers and large well-formed negative crystals (sometimes several arranged in parallel) were seen with liquid feathers. A similar combination of inclusions is only typical of yellow sapphires from the Balangoda area in Sri Lanka. Additional mineral inclusions documented in Thammannawa sapphires by Pardieu et al. (2012) included dark opaque crystals resembling uraninite, graphite, and spinel—along with dark green and colorless crystals resembling spinel and zircon, respectively.

Figure 18. These pendants feature sapphires from Thammannawa that weigh 4.6–6.2 ct. Composite photo by Sherrif Rahuman.

CONCLUSION

The discovery of commercial quantities of gem corundum from a weathered primary deposit at Thammannawa near Kataragama has revived gem mining activities in an area of Sri Lanka previously known to contain only hessonite garnet. Mining in the auctioned lands is progressing rapidly, and the collected gravel is still being washed. Geologists are working to find additional desilicated pegmatitic intrusions and associated micaceous layers that have gem-bearing potential. So far, a limited amount of these sapphires have been mounted into jewelry (e.g., figure 18). Nevertheless, this deposit—and the possibility of similar occurrences in the same area of Sri Lanka—could provide additional high-quality material for the sapphire market in the future.

ABOUT THE AUTHORS

Dr. Dharmaratne (dharme27@yahoo.com) is senior professor, and Dr. Premasiri is senior lecturer in geology, at the University of Moratuwa in Sri Lanka. Mr. Dillimuni is a consultant gemologist and tutor at Allied Gemmological Institute & Laboratory in Colombo, Sri Lanka.

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REFERENCES

Coomaraswamy A.K. (1903) Occurrences of corundum *in-situ* near Kandy, Ceylon. *Geological Magazine*, Vol. 21, pp. 348–350.

Cooray P.G. (1994) The Precambrian of Sri Lanka: A historical review. *Precambrian Research*, Vol. 66, No. 1–4, pp. 3–18, http://dx.doi.org/10.1016/0301-9268(94)90041-8.

Fernando G.W.A.R., Hauzenberger C.A., Hofmeister W. (2001) Origin of corundums in Sri Lanka: Evidence from case studies of in-situ deposits. *Journal of the Geological Society of Sri Lanka*, Vol. 10, pp. 37–47.

Fernando T. (2012) Biggest blue sapphire gem deposit found. *The Daily Mirror*, Feb. 23, p. A-3.

Geological Survey and Mines Bureau (1997) Kataragama-Tissamaharama-Yala geology map, Sheet No. 21, scale 1:100,000.

Gunaratne H.S. (1981) Geuda sapphires: Their colouring elements and their reaction to heat. *Journal of Gemmology*, Vol. 17, No. 5, pp. 292–300.

Hapuarachchi D.J.A.C. (1989) Some observations on the origin of gem corundum in Sri Lanka. *Journal of the Geological Society of Sri Lanka*, Vol. 2, pp. 5–9.

Hofmeister W. (2001) Interpretation of some typical Vietnamese gem mineralizations. *Proceedings of the International Workshop on Material Characterization by Solid State Spectroscopy: Gems and Mineral of Vietnam*, Hanoi, April 4–10, pp. 1–9.

Holzl S., Kohler H., Kröner A., Jaeckel P., Liew T.C. (1991) Geochronology of the Sri Lankan basement. In A. Kröner, Ed., *The Crystalline Crust of Sri Lanka*, *Part 1*. Professional Paper No. 5, Geological Survey Department, Sri Lanka, pp. 237–258.

Hughes R.W. (1997) *Ruby & Sapphire*. RWH Publishing, Boulder, Colorado.

Kroner A., Cooray P.G., Vitanage P.W. (1991) Lithotectonic subdivision of the basement in Sri Lanka. In A. Kröner, Ed., *The Crystalline Crust of Sri Lanka, Part 1*. Professional Paper No. 5, Geological Survey Department, Sri Lanka, pp. 5–21.

Milisenda C.C., Liew T.C., Hofmann A.W., Kroner A. (1988) Isotopic mapping of age provinces in Precambrian high-grade terrains: Sri Lanka. *Journal of Geology*, Vol. 96, No. 5, pp. 608–615, http://dx.doi.org/10.1086/629256.

Nizam I. (2012) Gem rush expected today. *The Island*, Feb. 23, www.island.lk/index.php?page_cat=article-details&page=article-details&code_title=45936 [date accessed: Feb. 26, 2012].

Pardieu V., Dubinsky E.V., Sangsawong S., Chauviré B. (2012) Sapphire rush near Kataragama, Sri Lanka (February–March 2012). GIA News from Research, www.gia.edu/research-resources/news-from-research/Kataragama_US_version_0503.pdf [date accessed: May 21, 2012].

Popov V.A., Popova V.I., Polyakov V.O. (2007) Regular intergrowths of minerals in pegmatites from the Il'meny mountains. *Geology of Ore Deposits*, Vol. 49, No. 7, pp. 573–582, http://dx.doi.org/10.1134/S1075701507070136.

Silva K.P.L.E., Wimalasena E.M., Sarathchandra M.J., Munasinghe T., Dissanayake C.B. (1981) The geology and the origin of Kataragama Complex, Sri Lanka. *Journal of the National Science Council of Sri Lanka*, Vol. 9, No. 2, pp. 189–197.