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SAPPHIRE RUSH NEAR KATARAGAMA, SRI LANKA (FEBRUARY – MARCH 2012)

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Figure 1: A fine blue sapphire crystal from the new find near Kataragama, Sri Lanka. Photo: V. Pardieu / GIA Laboratory Bangkok.

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ABSTRACT

In February 2012 a new sapphire deposit was discovered at a road construction site near the town of Kataragama, situated in the Monaragala District of Uva Province, Sri Lanka. The area has been known as a sapphire-producing area since the end of the 1970s (Zwaan, 1981). The Sri Lankan authorities were swift to react when news of the find broke, and after a brief gem rush the deposit was secured and an auction over the mining rights was organized by the National Gem & Jewellery Authority (NGJA). Official mining activity commenced in March 2012.

In collaboration with the NGJA, GIA organized two field expeditions to the area immediately upon learning of the discovery, in order to observe the rapidly evolving mining developments in the area and to collect samples for laboratory analysis and characterization.

Field observations of mining activity detailed in this report describe the sapphire mining and trading situation at the mining site, and present some information about the geology of the area and a description of the sapphires observed during the expedition.

It is believed that the deposit may be a primary deposit associated with a residual one, although this has not yet been confirmed.

The sapphires found thus far are fine, unworn crystals or crystal fragments of notably large size, with fine blue color typically confined to a narrow rim around the surface. Particulate bands, negative crystals, healed and unhealed fissures, and crystal inclusions such as graphite, mica, and spinel are typical internal features.

Rough crystals analyzed in the GIA Laboratory show moderate iron contents that are slightly higher than those typically observed in Sri Lankan sapphires from other deposits.

INTRODUCTION:

On February 23, 2012, Shamil and Arnil Sammoon from Sapphire Cutters Ltd. (Colombo, Sri Lanka) informed GIA's Bangkok Laboratory about a new find of blue sapphires located on the southeastern coast of Sri Lanka between Kataragama and Tissamaharama near the world-famous Yala National Park, one of Sri Lanka's major areas dedicated to conservation and tourism.

Yala hosts one of the world's highest concentrations of leopards, along with numerous deer, elephants, and a variety of birds including stunning peafowls, whose blue-colored feathers are a difficult challenge to match even for the best Sri Lankan blue sapphires.

Besides being one of the major tourist destinations in Sri Lanka due to the neighboring Yala National Park, the region has also been a very famous traditional Hindu and Buddhist pilgrimage center for many centuries, attracting thousands of pilgrims on weekends and holidays.

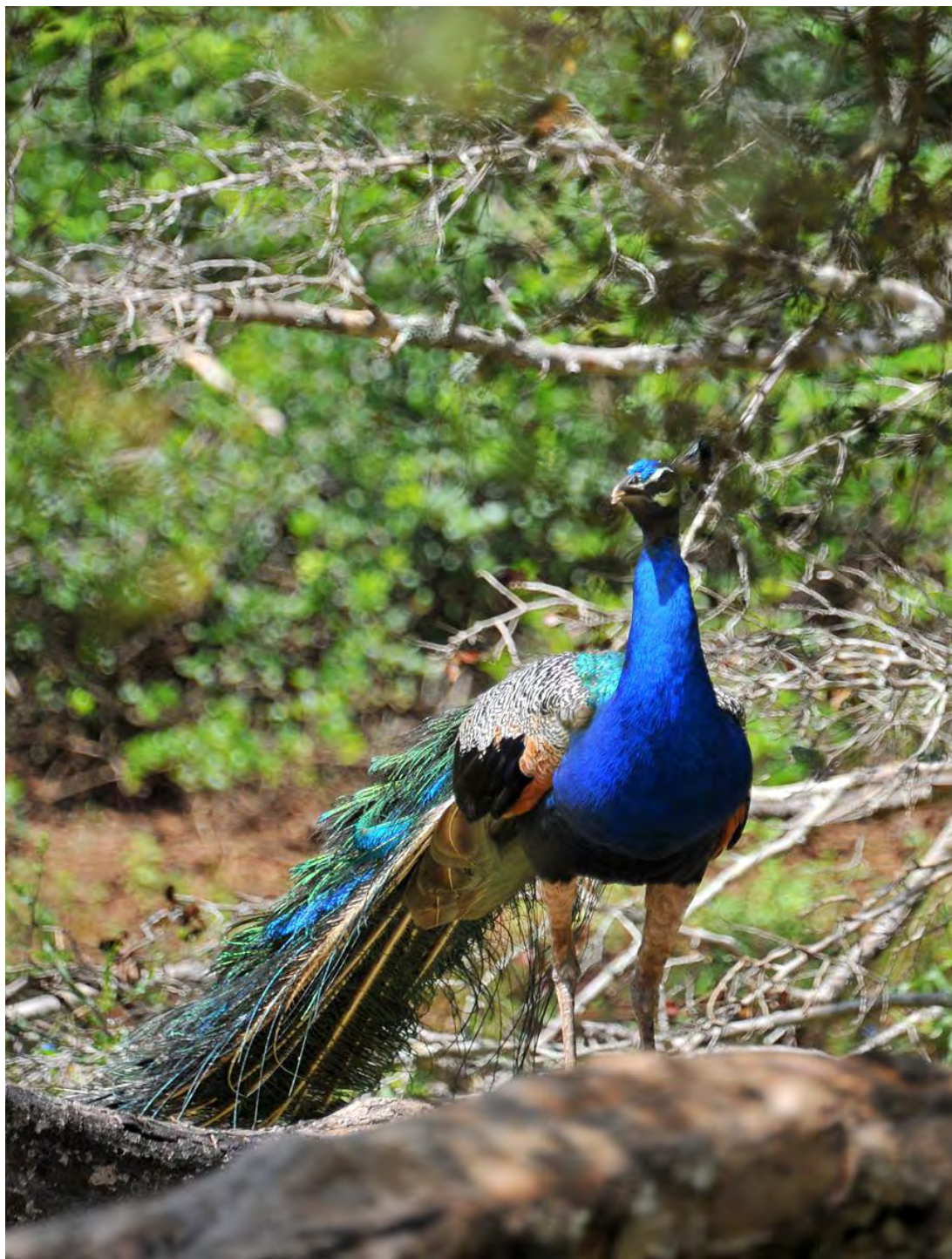


Figure 2: Peafowls from Sri Lanka and particularly from Yala are known for the beauty of their blue feathers. Photo: V. Pardieu / GIA Laboratory Bangkok.

Blue sapphires are not really something new in Kataragama: Since the end of the 1970s, blue sapphires have been found near Kataragama (Zwaan, 1982). They were discovered near Amaraweveva, about 10 km from Tissamaharama in the direction of Kataragama and at Kochipadana about 5 km east of Kataragama in the direction of Yala National Park.

According to Zwaan (Zwaan, 1981; Zwaan, 1982; Zwaan, 1986) at that time the sapphires were found in secondary deposits. Usually the stones were well-developed crystals with much less evidence of transport than other sapphires found elsewhere

in Sri Lanka. Consequently Zwaan believed that the primary was not located very far away, but he could not find it.

In 2012 nevertheless the rumor was that the new deposit was producing some large and very beautiful sapphire crystal specimens in qualities never seen before in the region and possibly on the whole island (see Annex B). This new discovery created a tremendous interest among Sri Lankan miners and traders, and also among the island media and public as many people believed that stunning stones would be produced from that new find.

That new deposit was seen as very good news by the Sri Lankan trade, because since the royal wedding of Prince William with Kate Middleton the demand for fine Sri Lankan sapphires has been very high.

The beautiful aspect of the sapphire crystals produced also raised the interest of gemologists and geologists about the nature of the deposit. The stones were indeed remarkable euhedral crystals specimens presenting no indication of weathering, indicating that they were probably coming from a primary-type deposit. Primary sapphire deposits are known in Sri Lanka near Avisawella, Bakamuna, Wellawaya, and Kolonne, but except for Avisawella (to some extent) they are not known to produce truly gem-quality material. The discovery of a primary-type sapphire deposit producing gem-quality sapphire would be quite noteworthy and interesting for the scientific community, and would finally confirm Zwaan's observations.



Figure 3: Pagoda surrounded by paddy fields, a common sight near Kataragama. Photo: V. Pardieu / GIA Laboratory Bangkok.

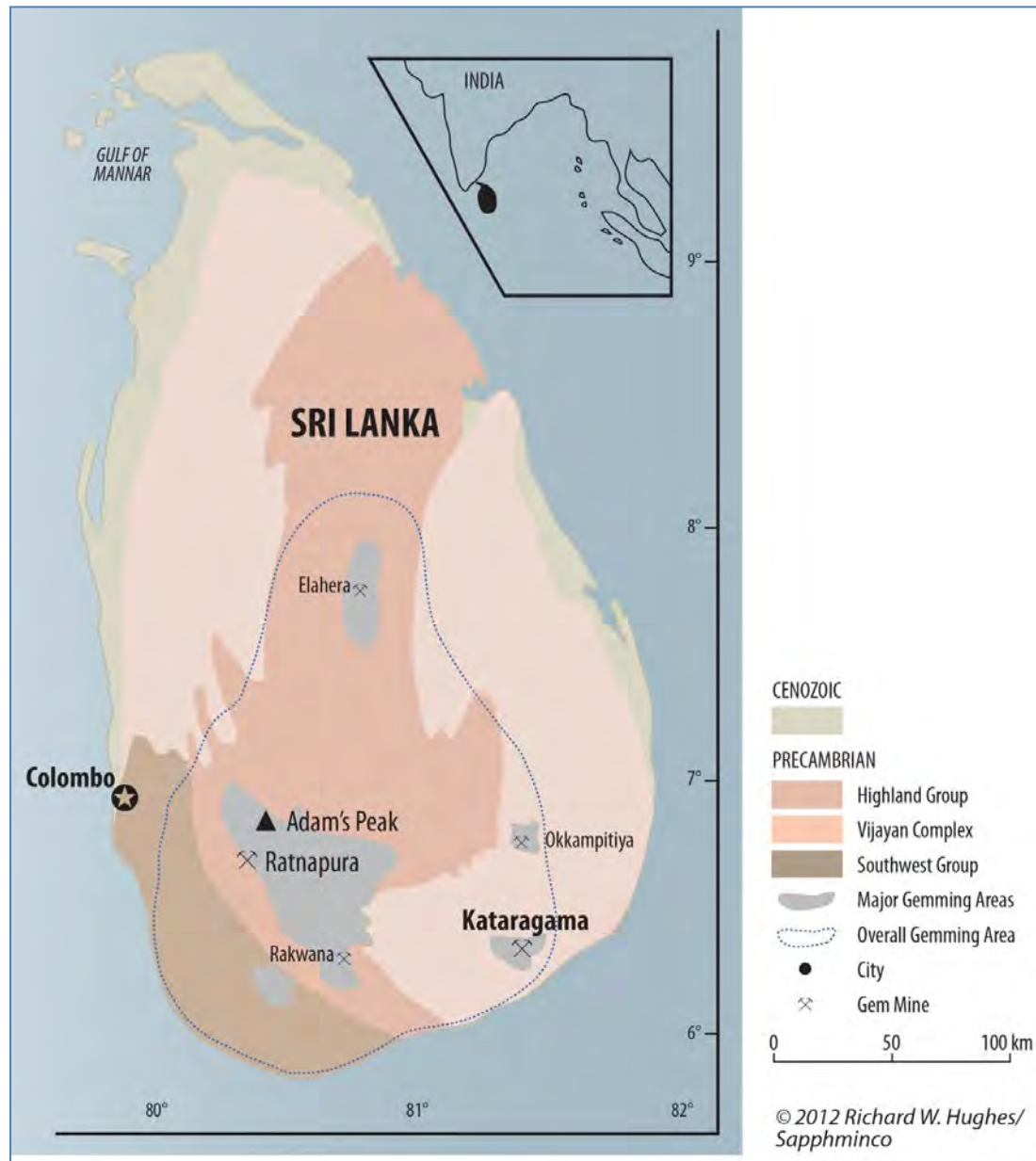


Figure 4: Simplified geological map of Sri Lanka with its main sapphire deposits. Map courtesy R.W. Hughes / Sapphminco, 2012.

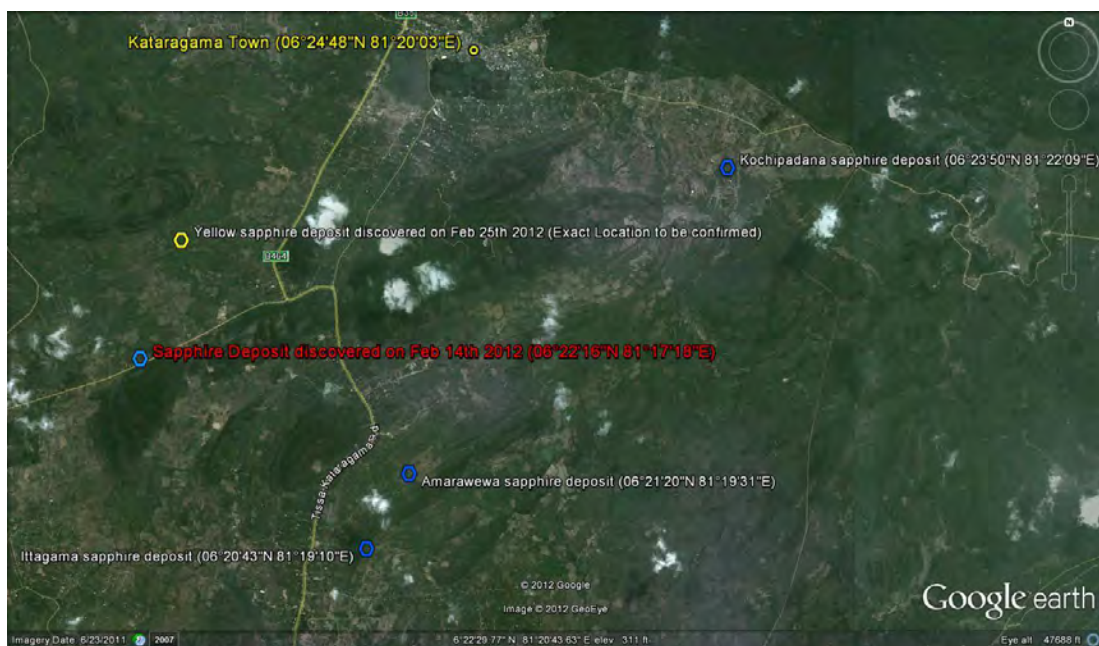


Figure 5: This Google Earth map shows the location of the new sapphire deposits (in red and yellow) recently discovered near Kataragama. The location of the other deposit in the area that has been known since the end of the 1970s is shown in white.

SAPPHIRE MINING AROUND KATARAGAMA – TISSAMAHARAMA BEFORE THE FEB. 2012 DISCOVERY:

Several studies of sapphires from the Kataragama – Tissamaharama area can be found in the gemological literature from the past 30 years (Zwaan, 1981; Zwaan, 1982; Zwaan, 1986; De Maesschalk, 1989; Hughes, 1997). Besides blue and yellow sapphires, Zwaan noted that the secondary deposits in the region also produce greenish blue spinels, garnets, zircons, tourmaline, beryl, scapolite, quartz, apatite, diopside, actinolite, sphene, and spodumene.



Figure 6: Local people mining sapphire near Ittagama in 2010 using a dry sieve technique. Photo: V.Pardieu / GIA Laboratory Bangkok.

In 2011 author VP visited the area while on a field expedition around Sri Lanka to collect sapphire reference samples for the GIA Laboratory Bangkok. During that expedition we witnessed some very low-scale sapphire mining. Local people mainly performed it illegally on land belonging to the Sri Lankan Forest Conservation Department.

In a forest-covered area near Kochipadana we met a group of five miners who first fled when the author and his team arrived on site, fearing them to be rangers from the Forest Conservation Department. Upon their return the author was able to study their production (Figure 7).

At Ittagama, an area close to Amarawewa, we met another small group of two miners (Figure 6) working the gem-rich soil using hand tools and some dry techniques to separate the sapphires from the reddish sapphire-rich ground. The gem mining sites visited were both secondary, residual-type deposits. The local miners were only interested by sapphires and were not collecting other minerals.

The author did not observe gem-quality material from the few stones presented by the miners, but the low-quality sapphires seen from their production were found to be very similar to the stones studied and described by Zwaan in the 1980s.



Figure 7: Yellow and blue low-quality sapphires seen from a miner working at Kochipadana in 2010. Photo: V. Pardieu / GIA Laboratory Bangkok.

THE FEBRUARY 2012 DISCOVERY NEAR KATARAGAMA – TISSAMAHARAMA:

According to the information gathered from the National Gem & Jewellery Authority (NGJA; see annex A), the deposit was discovered on February 15, 2012. However, some local people interviewed during the GIA Laboratory Bangkok field expedition to Kataragama reported that the deposit was first discovered as early as February 10, 2012, by workers on a road construction site between Kataragama and Lunuganwehera (located at 06°21'54"N, 81°16'20"E; see Figure 5).

As is commonly the case in most gem rushes, rumors are plentiful and it is sometimes difficult to separate fact from fiction. While visiting the mining site prepared by the NGJA, the road construction site where the discovery was made, and also the homes of many locals in the Kataragama area, the authors asked a number of people to describe their version about what happened in Kataragama. In response to their inquiries they received a variety of stories. To provide to the reader as much information as possible about the atmosphere around Kataragama during the GIA expedition, we chose to integrate some of these stories into the report—even if we could not confirm them—as they are quite useful to providing a picture of the situation at the time of our visit around Kataragama (see Box C: Rumors and secrets around Kataragama).

Most people agree that the new deposit was discovered on February 13, 2012, but a rumor persists that the discovery was made on February 10 by some workers while spreading some ground on the road construction site. In this version, during one

dumping of a truck-load of earthen soil, the road suddenly became blue with hundreds of sapphire crystals. One or two construction workers (from Ratnapura and/or Kandy) filled their helmets with several kilos these fine sapphire crystals and then disappeared with their treasure. According to the rumor for three days the discovery remained quite confidential, until a brief rainfall that occurred on February 13, 2012. Thanks to the rain that washed away the dust, for a few hours blue sapphire crystals became easy to spot on the wet road construction site. People started to find blue gems and called for support from relatives and friends. Within a few hours an all-out rush ensued. It started with children and women from the neighboring villages coming with all the tools they could gather from their homes to first collect the stones, when the ground was still wet, and then the gem-rich soil when it became dry again. Thanks to cell phones, the news of the discovery spread like brush fire, and within hours thousands of people descended upon the discovery area.

On February 14, 2012, between 10,000 and 30,000 people were reportedly busy mining on the road construction site. Eranga Basnayake, a Balangoda-based Sri Lankan gem miner and merchant, took the photographs shown in Figures 8 and 9 on that day as he rushed to Kataragama.



Figure 8: Local people rushed to the road construction site near Kataragama on Feb 14, 2012. A frenzied mining effort using hand tools or even bare hands soon commenced. Photos: Eranga Basnayake.



Figure 9: Local people taking away potentially gem-rich soil from the discovery site near Kataragama. Photo: Eranga Basnayake.

On the afternoon of February 14, 2012, the Sri Lankan police reportedly moved in to chase away the illegal miners and secure the construction site. While conversing with locals near the mining site, we were told the same story and some rumors about that event by a number of different people. All of them reported that on the evening of February 14 the police asked everyone to return home and remain indoors. Then during the entire night the local people said that they heard trucks going back and forth from the discovery site. Many locals suspect that the police, the army, or some other powerful group collected many truckloads of gem-rich soil during that time, possibly replacing the gem-rich ground with common soil. The authors could not confirm such rumors but heard them from many sources.

After control of the discovery site was secured by the police, the NGJA was officially informed on February 15. The organization moved swiftly: The NGJA first visited the discovery site on February 17. They found out that the soil being used in the construction project had been supplied from a small peanut and chili farm located nearby ($06^{\circ}22'16''\text{N}$, $81^{\circ}17'18''\text{E}$) that belonged to a private owner named Mr. Ranga.



Figure 10: In March 2012, Sri Lankan police controlled access to the mining site near the road construction site located on the right side of the road just beyond the hill shown here. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 11: The road construction site where the discovery was first made, as seen on March 8, 2012. Photo: V.Pardieu / GIA Laboratory Bangkok.



Figure 12: Mr. Ranga, the lucky 23-year-old Sri Lankan farmer who owns the farm where the sapphire discovery was believed to have been made. Photo: V. Pardieu / GIA Laboratory Bangkok.

Box A: Mr. Ranga's story about the new sapphire discovery near Kataragama

Until a few weeks ago, Mr. Ranga was simply a young farmer working on a small farm producing chili, onions, tomatoes, and peanuts. He had a project to build a new house on his farm, which had a small hill on it and was located near the road construction project between Kataragama and Lunugamwehera. He learned that one of the contractors building the road was searching for sand and soil to spread on the road construction site. He volunteered to sell the ground from the hill on his land for 100 rupees (a little bit less than US\$1) per tractor load. The contractor refused and proposed him 50 rupees per load. They agreed on that price and over the course of three months the contractor collected a just over 1000 loads from Mr. Ranga's land. During that period, he checked every load of his land as it was removed and thus had a very precise knowledge of where his land was collected and on what part of the road it was subsequently spread on. According to Mr. Ranga on February 13 a small rain had fallen in the area. Some little boys from the nearby village began to find blue stones on the wet road. Soon, many people from the nearby village (mainly women) and further away started to come to the road construction site to collect gems. The news about the discovery spread rapidly and soon a kilometer-long stretch of the road construction site was full of people. Mr. Ranga estimated that more than 40,000 people were in the area, either searching for gems or selling water and food to the diggers.

The people from the area had no knowledge about the stones and for the first few days mining occurred only along the road construction site. After this period some more experienced people inquired about the source of the soil that had been spread on the road. Mr. Ranga reported to the authorities that the earth had come from his farm. The area was then secured and sectioned off into 50 lots by the NGJA, of which 49 were auctioned on February 24, 2012 in Kataragama.

Mr. Ranga told us that he had sold his farm and his house to one of the people who had come to mine the area for US\$100,000 plus a mining partnership agreement. He said that he is now living in his mother's house. When the author asked him if he had collected some nice big blue sapphire crystals himself on the road, he had said that sadly he had not been lucky about that and was only able to collect some small samples that he had quickly sold. When asked if he still had any samples, he answered that he only had a few low-quality stones. The author was able to buy these from Mr. Ranga as reference samples for the GIA reference collection (D3 type samples, according to the GIA field gemology cataloguing system; see Annex C for more details). He also added that he was in fact very disappointed not to have been able to find any big stones on the road like some of the other people who went there, but he is still hoping that when they mine the land under his house in the future, they will discover many big gems.

The NGJA then had some discussion with the Forest Conservation Department, which owns the land in that area. They quickly came to an agreement to deal with the issue in order to ease the pressure from the numerous people anxious to mine the area. The ownership of 3.5 acres of land around Mr. Ranga's farm (where the source of the sapphires was believed to be located after an on-site visit by experts from the NGJA), was transferred from the Forest Conservation Department to the NGJA. That land was further divided into 50 mining lots (see Figure 13). The size of the mining lots was typically very small (about ten meters by ten meters), enabling only gem mining at the surface with hand tools. The NGJA organized an auction on February 24 in Kataragama offering one-year mining rights on 49 of these lots. The auction brought in a record 271 million rupees (about US\$2.5 million) in revenue for the NGJA despite the fact that the mining rights were given for only a year. Obviously the promising aspect of the nice-looking, large-size sapphire crystals found on the road construction site generated a great deal of interest and confidence in future prospects.

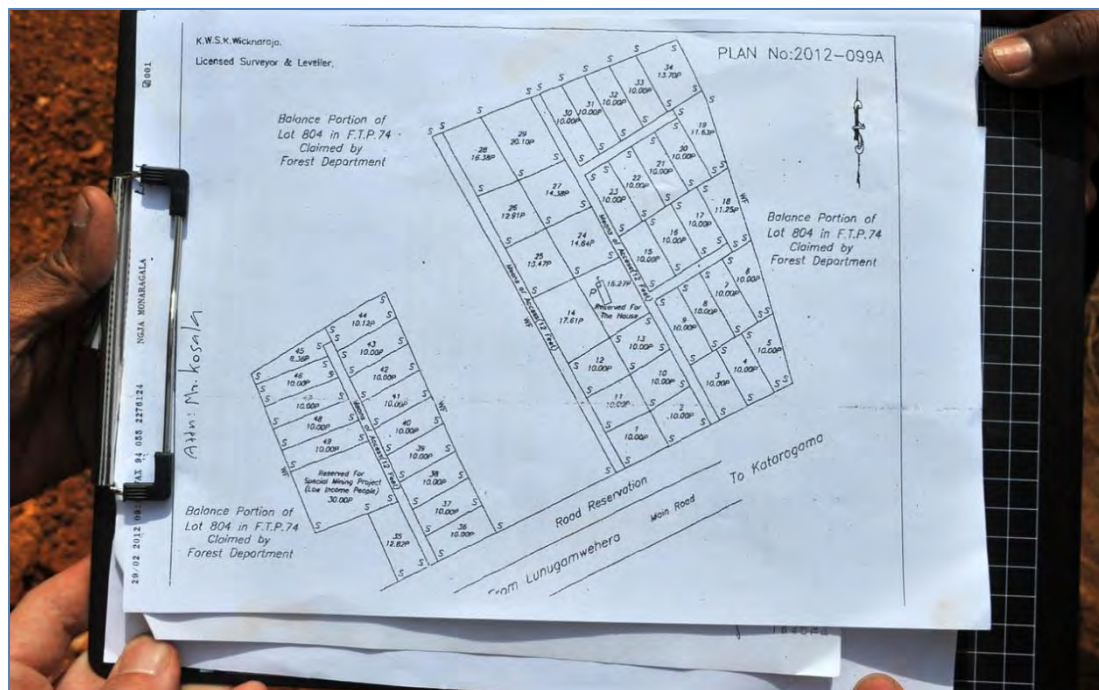


Figure 13. Authorities divided the land surrounding the new Kataragama sapphire deposit into the 50 mining lots shown in this survey. These lots were auctioned on February 24, 2012. Photo: V. Pardieu / GIA Laboratory Bangkok.

The news of the discovery and the record-breaking auction were widely reported in the local Sri Lanka media. The remaining lot (number 50 on the map Figure 13), was assigned to a special mining project for the benefit of low-income residents of the area. According to the NGJA chairman, 40% of the proceeds will be distributed to the landowners.

The miners were allowed to move on their lots contingent upon payment of their bids by February 28, 2012, but most of them arrived on February 29 or March 1 at the same time as the field gemologists from the GIA Laboratory Bangkok expedition.



Figure 14: NGJA official delivering on site a mining license on March 1st 2012. Photo: Andrea Heather Go.

Immediately in most mining lots small religious ceremonies were organized in order to please the local spirits and bring good luck to the miners. At the same time, access to the mining lots and the miners' camps were prepared.



Figure 15: A small shrine is left after the religious ceremony marking the opening of the mining site. Heavy machinery used to build access to the different mining lots is shown in the background. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 16: On March 1, 2012, the mining site is prepared by the NGJA. Photo: Andrea Heather Go.

THE GIA FIELD EXPEDITION (FE33):

Upon news of the discovery on February 23, 2012, a field expedition to the area was immediately organized by the GIA Laboratory Bangkok. Our objectives were to study the new deposit and obtain material for preliminary examination and characterization in the laboratory in order to be able to update the GIA's Origin Specific Corundum Database.

On February 28, 2012, a GIA Laboratory Bangkok team led by GIA Field Gemologist Vincent Pardieu with the support of gemologists Lou Pierre Bryl (F.G.A., Canada) and Andrea Heather Go (G.G., Canada) arrived in Colombo to visit the new area. Geologist and gemologist Boris Chauviré, at the time working in the field in Vietnam on blue spinel for his master's degree in Geology in collaboration with author Vincent Pardieu, joined the expedition on March 6, 2012, for a second visit to the new deposit near Kataragama.

On February 29, the GIA team met with NGJA officials, who arranged a special permit to visit the new mining area and provided contacts for several local NGJA officials and some miners. It was agreed that the GIA would share the research results with the NGJA.

On March 1, the GIA team reached the mining area after a 5-hour drive from Colombo.

During the first three-day-long visit (March 1-3) and then from March 7-8, 2012, author VP and his team conducted daily visits to the mining site with the support of officials from the NGJA. On these visits we usually followed sapphire "hunters" going from house to house to see if there were any stones worth buying.

VISITS AT THE MINING SITE:

During our regular visits to the mining site managed by the NGJA, we observed that the 3.5 acre area located at 06°22'16"N, 81°17'18"E, was being prepared to host an estimated 500 miners. The different mining lots had been well defined. The mining site was quiet and the whole installation appeared to have been well managed by the NGJA and the police. Within hours the miners started to arrive at their claims, and camps quickly sprung up on the recently cleared land.

Meetings were regularly held between officials of the NGJA and the miners to speak about mining, but they also addressed logistical issues like the use of machinery or sanitation. We witnessed several officials and media representatives visiting the mining site while machinery was being used to build the access to the different lots according to the map (Figure 13).

Miners began work immediately upon arrival, loading the potentially sapphire-rich soil into bags to be taken away for washing. The area is very dry and thus does not enable to miners to wash the potentially sapphire-rich soil covering their mining lot on site. The fact that washing was performed up to several kilometers away from the mining site did not permit the authors to see whether there was any production from particular mining operations.

We were welcomed by the miners, who were very pleased to invite us to visit their operations. It was remarkable to find out that few of them had any knowledge or understanding of the geology specific to the mining site. Most of them were here obviously trying their luck.



Figure 17: View of the mining site with lots defined by simple ropes as we saw it upon our arrival on March 1, 2012. Note the large rocks on the right; these were reportedly placed here to secure one of the areas believed to be among the best and to prevent unauthorized digging. Photo: Andrea Heather Go.



Figure 18: An NGJA official is shown meeting miners on March 1 at the mining site. We witnessed such meetings regularly during the next days. Photo: Andrea Heather Go

Box B: An aside about mechanized mining versus gem mining using only hand tools in Sri Lanka

During the FE24 expedition to Sri Lanka in March 2010, author VP and his team witnessed numerous gem mining operations across Sri Lanka using excavators and machinery (GNI 2010). Nevertheless, the use of heavy machinery was an issue in Sri Lanka and in June 2011 the NGJA stopped issuing licenses for mechanized mining. When author VP visited Sri Lanka again in January 2011, mechanized mining was much less common and many gem miners were quite unhappy about that. At Kataragama from March 1-6, 2012, only hand tools were allowed at the mining site. Some excavators were visible but they were used only to build access to the different lots and not for mining gems. However, the miners encountered problems with hard rock, and on March 07 during a meeting between the miners and Mr. W.H.M. Nimal Bandara, Director General of the NGJA, we witnessed an announcement that the NGJA would allow the use of excavators to remove heavy rocks that were problematic for the miners.

On April 3, 2012, we learned from a Sri Lankan gem merchant visiting Bangkok that the NGJA decided the week before to reissue licenses for miners permitting them to use machinery under certain conditions while mining for gemstones in Sri Lanka.

Box C: Rumors and secrets around Kataragama

In most gem rushes, rumor is an essential ingredient of the frenzy surrounding the discovery of new gem deposits. Speaking with different local people and with the Sri Lankan gem merchants and miners from all around the country who came in Kataragama, the author heard many of these stories and rumors. It was very difficult to separate fact from rumor.

Mr. Ranga himself was very keen to tell us about two stories: The first was that when the earliest miners came to his land they saw a huge snake. According to him, the animal was a gigantic white cobra that came out from a hole at the location where he believed the sapphire-rich soil had been taken to be spread on the road. Sadly the snake was killed, but Mr. Ranga believes that this snake was a kind of spirit that was showing them where the best stones were located. That same lot, lot number 2, is about 10 meters by 10 meters; it was later auctioned for a record-breaking amount of US\$200,000 for one-year mining rights.

We also heard another story about a monk who had lived in the nearby temple. That old monk, who has passed away a few years ago, used to say that in the area was a hidden “blue flower palace” (“Nilmatalasa” in Sinhalese) that would make the villagers very rich the on day they were able to find it. It is interesting to note that such religious stories are to be expected around Kataragama, as the people in the area are known to be very religious. In fact, Kataragama is quite famous in Sri Lanka for its holy sites, and several important pilgrimages take place in the area each year.

All types of rumors could be heard from people around the site, including one story about the workers believed to have collected kilos of gems on February 10 and then disappeared with their treasure, or another tale about many trucks that came to the area and took away most of the gem-rich soil during the night, before the NGJA secured the area, while the police helped by sequestering people inside their homes...

Many people said also that during the first days of the discovery the local people had no real idea about the value of the gems. Many fine gems were then sold for merely a few dollars to the Chamila Company, the main local gem merchant, or to the first gem merchants from Colombo, Ratnapura, or Beruwalla who arrived on site. Then as the local people began to hear that the value of the gems they had collected was in fact much higher than the price for which many of them had been sold, everybody became hesitant to sell any gem at a reasonable price. We were told that this was the reason why, when we visited the area, the prices asked by the locals even for small low-quality gems were unbelievably high. Many merchants and locals were very reluctant to show any gem they had purchased or found, as they were afraid of the growing rumors. Visiting the new mining site after a rapid survey of the area, the author also found that most lot owners had no solid understanding of or experience working the type of deposit they were mining. The acquisition of the lots was clearly more the result of a gamble than of a careful study of the local geology. As some merchants told the author, in fact, most people were here to try their luck...



Figure 19: Miners are shown on March 1 collecting potentially sapphire-rich soil in bags to be taken away and washed offsite. Photo: Andrea Heather Go.

We were regularly asked if in our opinion they had any chance to procure some sapphires from their lot. We had a simple answer: We were here to study the deposit, and in order to be able to say anything we must first see some sapphires coming from that place and study the geological context in which they were found. Only then would we—possibly—be able to provide an opinion based on our observations. Sadly during the five days we spent on site we were not able to see any sapphire in matrix and confirm that the site was a primary deposit as was suspected by the NGJA.

From March 1-3, 2012, we visited the mining site twice a day to monitor the mining progress. We hoped to observe sapphires being mined from the area, which was reported by NGJA officials to be a primary deposit. Unfortunately, on March 3 the only gems that were found in kaolin-rich pockets were brownish green dravite-like tourmaline, spinel, garnet, and quartz. No sapphire had reportedly been found yet on the new mining site near Mr. Ranga's house, so VP made a decision to extend his visit in Sri Lanka so that he could visit the mining area again on March 7-8, and give the local miners more time to continue digging and hopefully find some stones.

On March 6 while LPB and AHG returned to Thailand, VP was joined by geologist-gemologist Boris Chauvire for the second segment of the expedition.



Figure 20: Within a day the miners built tents and basic infrastructure in order to improve their working conditions in the dry and hot area. On March 2, the area already had the semblance of a mining site. Photo: Andrea Heather Go.



Figure 21: On March 7, one week after the start of mining, the new mining camp appeared well organized. Photo: V.Pardieu / GIA Laboratory Bangkok.



Figure 22: On March 8, while the use of excavators had been approved for moving large rocks, miners were still seen filling bags with potentially sapphire-rich soil. Photo: V.Pardieu / GIA Laboratory Bangkok.

During that expedition authors VP and BC visited the mining site on March 7-8, 2012, and because the different mining groups had already been able to dig for a week, we could focus this time studying these diggings. That second visit was then very useful to get a better idea of the geology of the area. An additional positive point was the presence at the time of our visit of Gamini Zoysa, a well-known independent Sri Lankan geologist and gemologist who is very knowledgeable of the island and its gem deposits and who generously shared with us his experience and observations.

Thanks to Gamini Zoysa the authors were also informed on March 7 that it was possible to visit the road construction site where a few hundred local people were still working.

On the following day, March 8, the authors were able to visit the construction site located at $06^{\circ}21'54''\text{N}$, $81^{\circ}16'20''\text{E}$ where the sapphires were first discovered around February 14. About 200 local people from neighboring villages were working there. Men, women, and children were digging here or there trying their luck. It was interesting to meet numerous local people who witnessed the discovery and to collect from them some stories and sapphire samples (B and C type samples; see Annex C) for the GIA reference collection.



Figure 23: Local Sri Lankan people seen working on the road construction site on March 8, 2012. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 24: A young Sri Lankan girl presenting a small sapphire she found on the road construction site near Kataragama. Photo: V. Pardieu / GIA Laboratory Bangkok.

It was also interesting to see that some of these local people had in their pockets, not only genuine sapphires mined on the road near Kataragama but also some very skillfully carved synthetics and some waterworn stones that were probably mined far from Kataragama and possibly even treated. It is just a common occurrence in mining areas: Some people arrive with tools to dig the ground, other with money to buy gems, and some others carrying synthetics and stones they had problems selling believing that thanks to the local gem fever they will find a buyer... We could see on

several occasions that the old “Dick Law” presented by Richard W. Hughes in “Ruby and Sapphire” (page 117) which states that “the closer you go to the mines and the more likely you are to be presented some synthetics or imitations” clearly applied here around Kataragama.

As we left the mining site on March 8 we learned that several groups of miners had also decided to return home, as they had not been able to find any stones so far in the lot. According to some of them they will wait to get news about further discoveries before they consider resuming mining their lot.

As of our departure on March 9, 2012, no sapphire had reportedly been found at the different mining lots around Mr. Ranga’s house auctioned by the NGJA.

Beginning in April 2012, while contacting different miners met near Kataragama, and also corresponding with officials from the NGJA, author VP was told that during the first month of mining at the site organized by the NGJA, the miners had found sapphires washing from the soil collected off the top portion of their mining lot. The stones collected were mostly under ten carats rough, but they were also happy to have found some very nice sapphire specimens weighing up to 50 carats.

Nonetheless, as of April 15, 2012, the authors had not yet received any report that sapphire had been found in situ in hard rock or in a pocket-type structure.

WITNESSING THE SAPPHIRE TRADE AROUND KATARAGAMA:

At the end of each of our daily visits to the mining site, thanks to the support of several Sri Lankan gem miners and merchants, we were able to enjoy some gem hunting around Kataragama.



Figure 25: Following the rumors and hunting for big blue gems using a good car, scouts on motorbikes, and mobile phones. Photo: V. Pardieu / GIA Laboratory Bangkok.

Each evening we typically joined one of the cars going from place to place to see if this or that stone they heard about was worth buying. Modernity—particularly with cell phones and cars and motorbikes—had a tremendous impact on gem trading in areas like Kataragama as gem buyers drive all over the countryside in their vehicles while speaking on the phone with their suppliers. It is a hunting game where some hunters seek good stones while others search for good customers. It is not without risks as many people in a gem rush get affected by a buying fever.



Figure 26: A Sri Lankan sapphire buyer checks the clarity of a big blue rough sapphire in a private house near Kataragama. Photo: V.Pardieu / GIA Laboratory Bangkok.

As usual when demand is high and when some afflicted with a gem buying fever lose their common sense and wisdom, unscrupulous people bring certain stones to sell at the gem rush area: These can be fine gems searching for a market, but also synthetics, imitations, or stones mined from other places. Understandably, gems are taken to where prices are good and where people are willing to buy them. A gem rush is a perfect place for that...Thus, during our visits to private houses around Kataragama, we were not very surprised to be offered synthetics, or stones more likely to have been mined from secondary deposits in Sri Lanka, Madagascar, or possibly also Tanzania. For buyers willing to buy only genuine sapphires from the area, the gem hunting game can be quite tricky. The first buyer to be on site will get a clear advantage, particularly if the local people don't know much about gems. Then when competition arrives, buying strategies change because if a buyer wants to have first sight on fine large material, then it is important to be known as giving good prices. But too much exposure can also be dangerous...It is a tricky game, one that needs many years of experience or a lot of talent to master: During a gem rush more than in a quiet market taking place regularly here or there, speed is a key factor; but one should be very careful because in such places trust competes with greed, ignorance with knowledge, and wisdom with a gambling spirit. During the fever of gem rushes, some lucky poor people can become suddenly very rich while some overconfident rich players can lose a fortune and also their reputation buying the wrong stones.



Figure 27: Kataragama villagers washing the gem gravels they collected on the road construction site in a lake near Kataragama. Photo: V. Pardieu / GIA Laboratory Bangkok.

It was simply fascinating to witness this game between the buyer and seller in the surrounding villages, and funny to see that a shy-looking fellow who one day came to meet you on an old bicycle might visit you the next day with a big smile driving a brand new motorbike or a new car...



Figure 28 : Understanding if a rough sapphire is worth buying and assessing its value are not skills that are learned in few days. It usually takes years and the support of some very experienced mentors to gain such knowledge. Photo: V. Pardieu / GIA Laboratory Bangkok.

During our stay in Kataragama we visited mainly local residents who had reportedly found sapphires from the gem-rich soil spread on the road construction site. We also tried of course to visit the local gem merchants, and particularly the Chamila Company, settled in the area for many years and known among the gem mining and trading community in Kataragama to have been very active buying sapphires from the new deposit from the time of its discovery. That last part turned to be the most difficult part of the expedition as these local merchants simply refused to meet us, telling us that they had no stones. That was very difficult to believe...

The reasons for their refusal were probably multiple, and we speculated on them: Immediately after that discovery, merchants who had been established for years around Kataragama were among the first to buy sapphires. The rumor was that they had been able to buy kilos of these sapphires for essentially nothing, as the local people who mined along the road had no knowledge about sapphires, their qualities or characteristics, and their value. The situation changed rapidly in the days following the discovery: Competitors arrived and thanks to the media coverage and the news about the record-breaking auction, we were told that many local people sensed that they sold their stones too cheaply during the first days of the rush. With numerous buyers coming from all over Sri Lanka, the demand increased while at the same time, as most people hesitated out of fear of selling their stones too cheaply, prices within hours or days increased dramatically.

The merchants who bought stones cheaply during the first hours and days of the rush were then reportedly under a great deal of pressure from both sides: First from the people who had come to believe that they sold stones for less than they were worth and consequently felt that they had been ripped off, but also from buyers arriving in the area from all over the country interested in seeing their stock with the intent to buy from them or just to get a better idea about production in the area. For many of them it was too much and—quite understandably—they wanted to be quiet.



Figure 29: After spending a day at the mines and listening to Mr. Ranga's story, the author and his group check a fine blue sapphire specimen found near Kataragama. Photo: Andrea Heather Go.

In March 2012 around Kataragama, as was the case for all the gem rushes the author has previously experienced, rumors and secrets were omnipresent. But thanks to the support from Nalin De Fonseka, Careem Hilmy, and Suchan Fernando, and despite the lack of collaboration by many local merchants, we were able to see many significant interesting large stones and also collect interesting specimens from multiple independent sources for the GIA reference collection (see the section on field observations of rough crystals below for details).

GEOLOGY OF THE NEW SAPPHIRE DEPOSIT NEAR KATARAGAMA:

Sri Lanka, known sometimes as the “gem island”, has very old gem mining traditions, thanks to its specific geological background. The geology of Sri Lanka is very close to that of another gem-rich island: Madagascar. In fact, the two islands' rocks record the entire process involved in the assembly of Rodinia (a supercontinent formed from most or all landmass existing between 1.25 Gy and 750 My) and his dispersal followed by re-assembly of some of lands into Gondawana supercontinent between 1.3 Gy and 550 My (Kröner et al., 2003). The main process recorded in Sri Lankan rocks is the Pan-African orogeny (i.e., mountain-building tectonic event) between ~950 My (or 800 My according to some studies) and ~550 My (Widanagamage, 2011; Kröner et al., 2003; Meert and Van Der Voo, 1997). This orogeny led to the formation the supercontinent Gondawana which is constituted by present-day Africa, South America, and Persian Gulf along the western portion and India, Antarctica, Australia, Madagascar and Sri Lanka along the eastern portion (see Figure 30; Collins et al., 2012; Kröner et al., 2003; Dissayanake & Chandrajith, 1999).

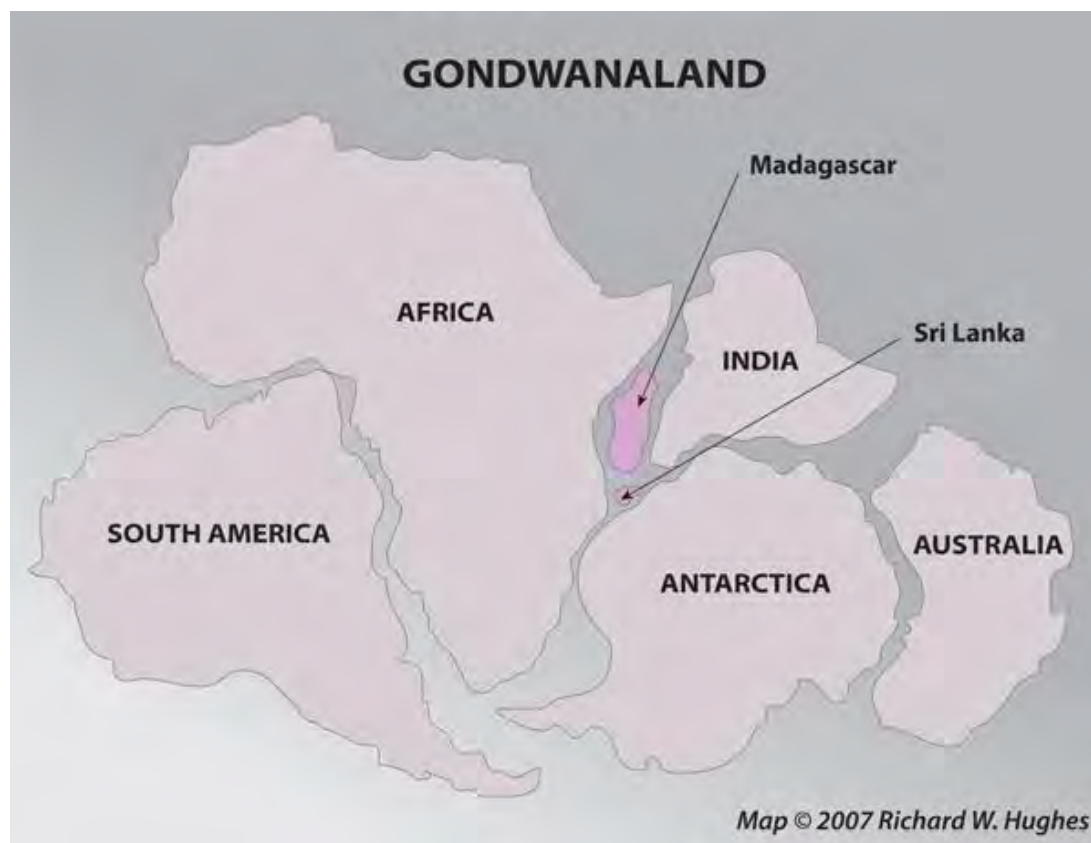
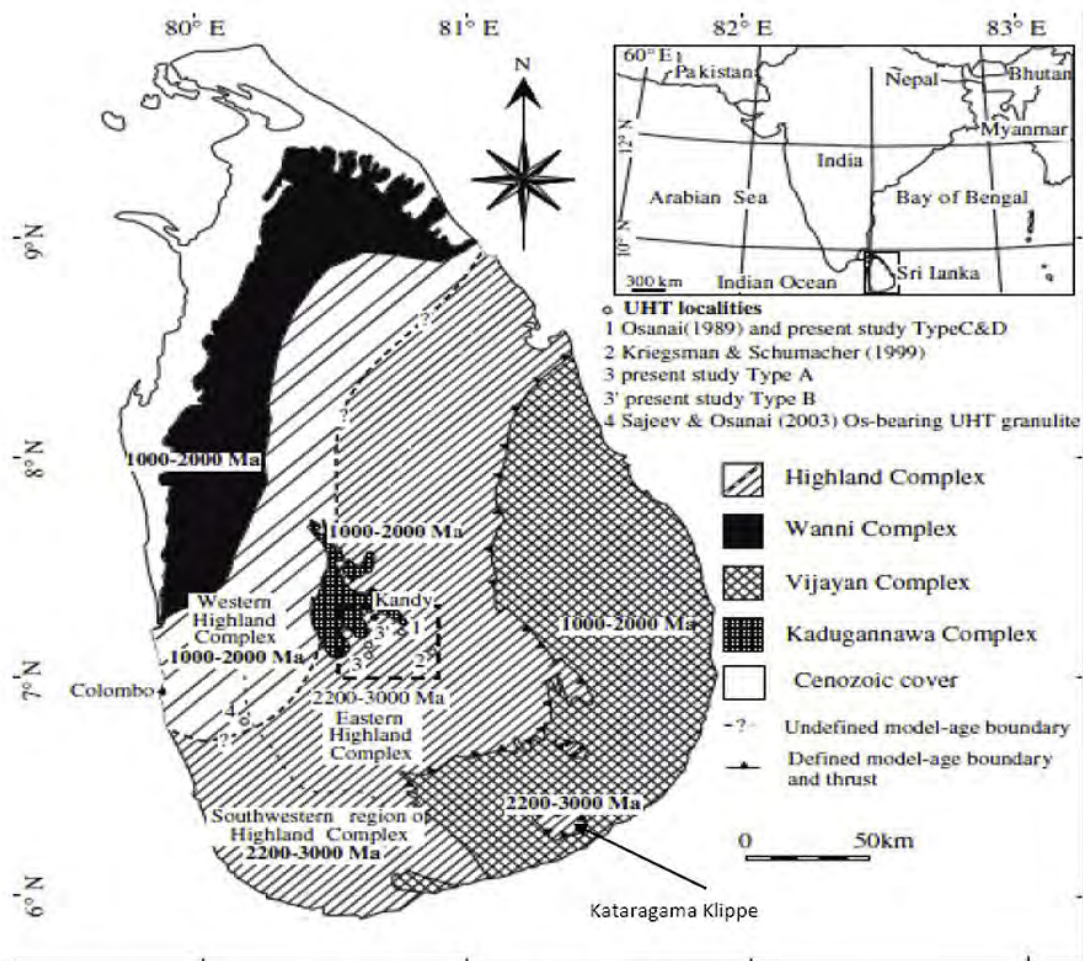


Figure 30: A presentation of what "Gondwanaland" might have looks like 700 million years ago with the possible locations of the continents and islands we know today. Courtesy: R.W. Hughes.

The location of Sri Lanka in Gondwana remains enigmatic, but rocks constituting this island are very similar to rocks in the Mozambique Belt formed by the Pan-African orogeny (Kehelpannala and Collins, 2006; Dissayanake and Chandrajith, 1999; Meert and Van Der Voo, 1997).

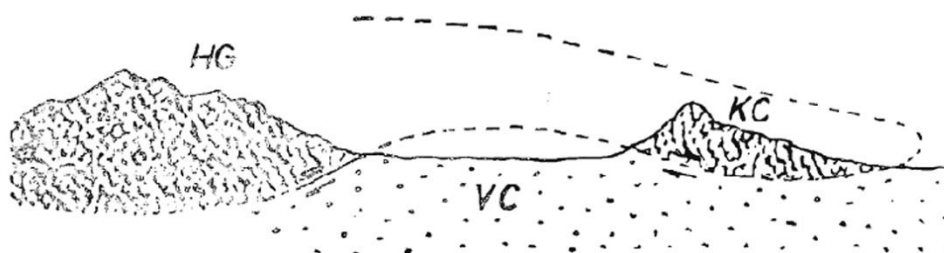
Sri Lanka is mainly constituted by four complexes (without Cenozoic cover). From north to south, there is a Cenozoic cover, the Wannu Complex, the Highland Complex, and the Vijayan Complex. The last complex, named Kadugannawa, is at the boundary between Wannu and Highland Complex (Sajeev and Osanai, 2004; Kröner et al., 2003; Gunaratne and Dissayanake, 1995) see Figure 31.

The Kataragama deposit is localized in the southern part of Sri Lanka on a klippe (a klippe is a remaining outcrop of a geological unit which is overthrust onto a second unit) formed by rock of Highland Complex and surrounded by Vijayan rocks (Silva et al., 1981; Dissanayke et al., 2000).



Geological setting of Sri Lanka. Map from Sajeew & Osanai 2004.

Figure 31: Simplified geological map of Sri Lanka. Map from Sajeew and Osanai, 2004.



Cross section to explain Kataragama complex as Klippe. HG is Highland Group (also named Highland Complex); KC is Kataragama Complex ; VC is Vijayan Complex. Dotted line represents the Highland unit before weathering. Schema from Silva et al. 1981.

Figure 32: A schematic representation of the Kataragama Klippe (KC). Schema from Da Silva et al. 1981.

The Highland Complex is constituted by Precambrian rocks (mainly sedimentary rocks; Dissanayke et al., 2000) dated about 2-3 Gy (Widanagamage, 2011; Sajeev and Osanai 2004) which underwent a strong, high-grade granulite facies metamorphism about 550-610 My during Pan-African orogeny according to Widanagamage (2011) and about 1.1 Gy according to Kröner et al. (1987). The Kataragama complex is mainly constituted by garnetiferous charnockite, granulite (more or less garnetiferous), and limestone. Sometimes, a small-scale unit of quartzite, pegmatite, and gneisses with hornblende is described (Silva et al., 1981). This klippe is surrounded by another geological unit named the Vijayan Complex, mainly constituted by amphibolite facies metamorphic rocks (Dissanayke et al., 2000).

This new deposit seems to be a primary-type sapphire deposit, meaning that unlike what is commonly found in the rest of Sri Lanka, the sapphires are not found here in gem-rich gravels resulting from the weathering of gem-rich rocks over millions of years of weathering. On the mining site, the authors did not see any stones in matrix, but the shape (very good crystal forms) and the aspect of these sapphires (not rounded as a result of weathering) give strong indication that this deposit is probably (at least partially) primary, as it is also possible that a residual deposit exists over a primary deposit.

The geological map made by the Geological Survey and Mine Bureau of Sri Lanka in 2002 and shown in Figure 33 provides the geological context of the deposit.

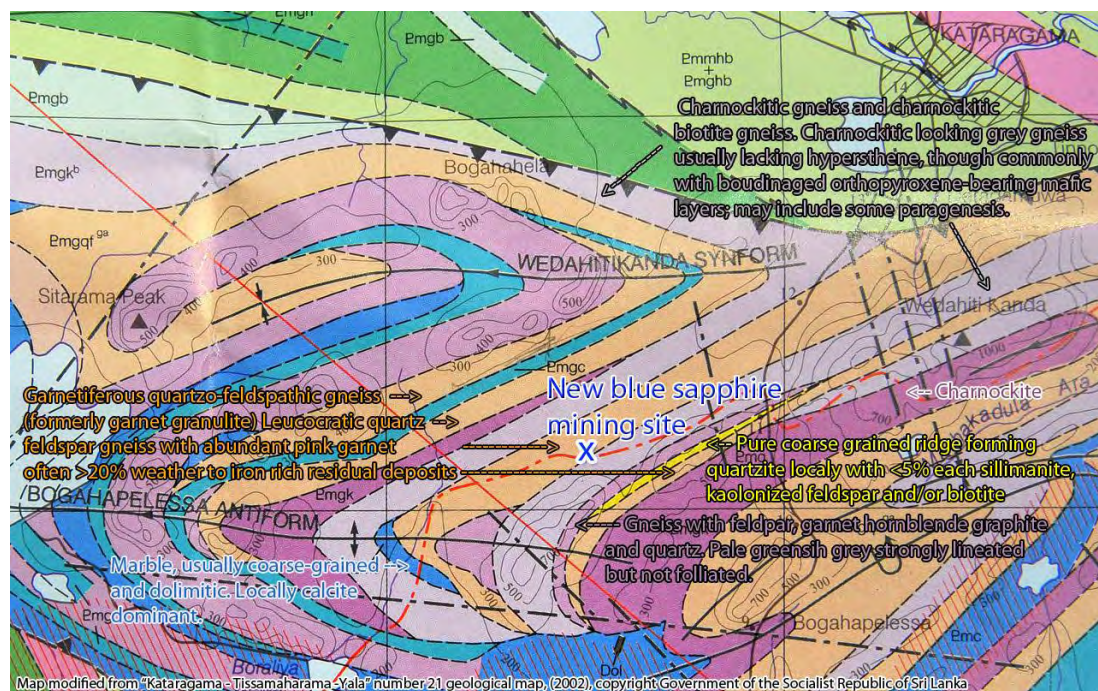


Figure 33: Detailed geological map of the area surrounding the new mining site. Map modified from "Kataragama-Tissamaharama-Yala," number 21 geological map (2002), copyright Government of the Socialist Republic of Sri Lanka.

The deposit is localized near a limit between two geological units in the north side of the Bogahapelessa antiform. At the northwest, there is a garnetiferous quartzofeldspathic gneiss (formerly garnet granulite proper to the Kataragama complex) and in the southeast, there is a charnockitic gneiss (see map). Visiting the deposit on March 7-8, the authors could see that most of the area covered by the mining site is composed of granulite type rocks (similar to those described by the

geological map), with a strong lineation carried by tubular quartz with a direction between N50E and N60E (see Figure 34). This rock (Figure 35) is mainly constituted by feldspar (about 80%), quartz (about 15%) and red to brown garnet (about 5%).



Figure 34: Granulite type rocks with a strong lineation carried by tubular quartz with a direction between N50E and N60E seen on the mining site. Photo: V.Pardieu / GIA Laboratory Bangkok



Figure 35: Details on the granulite type rocks samples collected on site in Kataragama by the authors. Photo: V.Pardieu / GIA Laboratory Bangkok

In a small area of the mining site near the road (Figure 36), we could see several silica veins (mainly quartz and chalcedony) with a thickness between five millimeters to several decimeters.



Figure 36: View on the outcrop visible on the mining site on March 02. Photo: V.Pardieu / GIA Laboratory Bangkok

Around these veins, we noticed several decimetric lenses (Figure 37). The lenses were mainly composed of a white powder (probably kaolin) associated with graphite. Mica (white and millimetric, probably muscovite) was also found sometimes at the rims of some of these lenses.



Figure 37: Kaolin rich lense seen on the outcrop on lot number 6 near Kataragama. Photo: V.Pardieu / GIA Laboratory Bangkok

Miners told us several pocket like these were found, and some of these were filled with some bluish green to brown dravite-like tourmaline (see Figure 38). It was interesting to notice that the white kaolin-like powder observed on site in these pockets was very similar to white powder we saw inside many cavities and fractures from sapphire reportedly mined from the new mining site.



Figure 38: Tourmaline crystal specimens found from pockets on the mining site. Photo: V. Pardieu / GIA Laboratory Bangkok.

Silica-rich rocks surrounded all the pockets the authors were able to study on site. For corundum to be able to form, potential sapphire hosting rocks have to be depleted in silica. In the field, we could not see any silica-poor rocks to play the part of silica sponge and enable the formation of corundum from such pockets. But, studying the area geological map, we noticed that the Sri Lankan geologists who studied the area wrote about lenses (boudinage) of orthopyroxene-bearing mafic rocks into charnockitic rocks in the unit situated at the south of the mining site. Contingent on petrology of these mafic rocks, the interaction between these two rocks could potentially provide the right geological environment to produce sapphires, but the authors did not observe these rocks in the field during the brief expedition.

It is nevertheless interesting to observe that the geological settings and the aspect of the sapphires found near Kataragama are not without similarities with other known sapphire deposits visited and studied by author VP at Andranondambo in the south of Madagascar (Schwarz, Petsch, et al. 1996) and near Avisawella in Sri Lanka (Kumaratilake and Ranasinghe, 1992), where sapphire are found in kaolin-rich pockets associated with mica. In Andranondambo, the geological context is nevertheless slightly different as these pockets are also associated with pyroxene and marbles, two minerals we did not observe at the mining site near Kataragama (Figure 39). In Andranondambo, a geologist with nearly five years' experience working for SIAM, an Australian sapphire mining company excavating there since 2005, explained to author VP that he was using mica as indicator to find sapphire-rich pockets, and according to him, sapphires were only found in pockets with thick mica and a thick pyroxene rim.

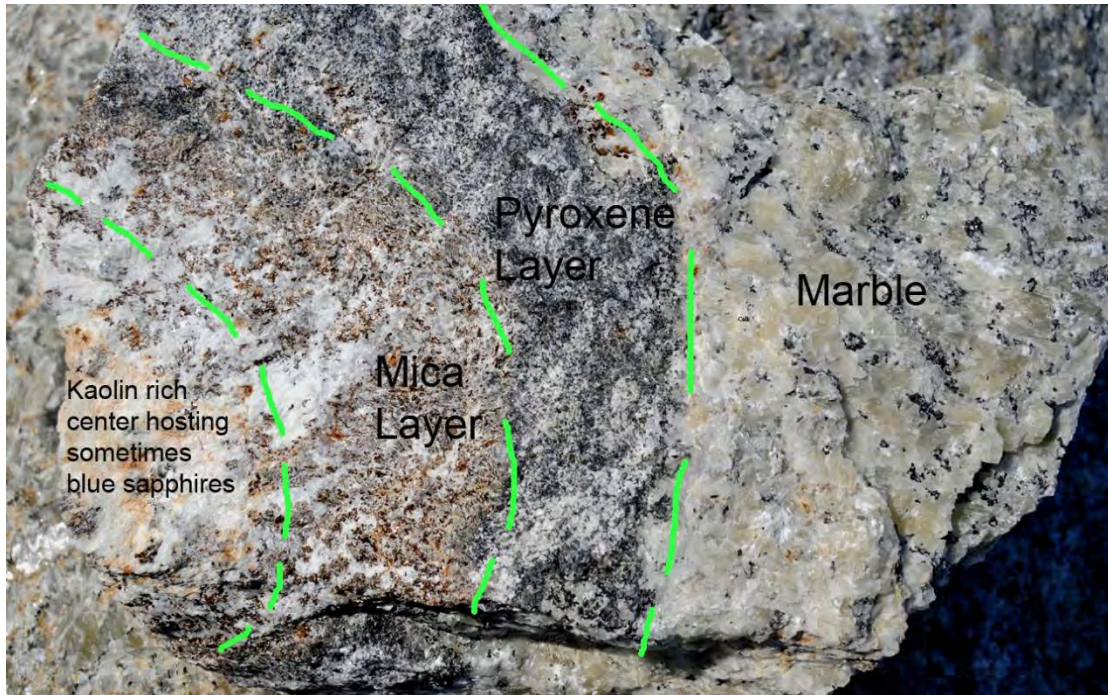


Figure 39: Piece of rock taken from a pocket in Andranondambo (Madagascar) showing the different mineral layers associated there with the blue sapphire rich pockets. Photo: V.Pardieu / Gubelin Gem Lab, 2008

Near Kataragama the authors observed several pocket-like bodies composed of kaolin-like white powder associated with graphite and surrounded by a very thin layer of mica. These pockets did not contain any sapphires, but the presence of such pockets suggests to us that the area may possibly host pocket structures that could be the source of the sapphires found in Kataragama.

The study of the inclusions in the Kataragama sapphires we collected is consistent with this supposition, as mica, feldspar, graphite, and green spinels are among the most common mineral inclusions found in these stones.

Based on the field observations and the inclusion studies of these sapphires, the hypothesis that the sapphires from the new deposit near Kataragama originate from kaolin/mica/graphite-rich pockets seems to be the most likely explanation. Nevertheless, as the authors did not observe any sapphire-rich pockets on site, this hypothesis still needs to be confirmed.

To confirm the nature of the deposit, assess its potential, and determine which mining strategy will be best to work it in the following years, a complete geological survey of the area should be planned. That survey should include not only the current mining site that was delineated by the NGJA and the Sri Lankan Forestry Department, but also the hill on the other side of the road building site on the south of the deposit. The reason for this recommendation is that during the field expedition to the mining site, the most promising areas were the areas where the kaolin-rich pockets were found; i.e., the areas close to the road-building site (Figure 13).

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FIELD AND MARKET OBSERVATIONS OF ROUGH CRYSTALS SEEN AROUND KATARAGAMA:

The sapphires the authors observed during the FE33 expedition to Kataragama were either fine crystal specimens or broken pieces with sharp edges and no indication of alluvial transport.

Fissures and cavities were commonly filled with a white, powdery, kaolin-like material, and in some rare cases with brownish iron stain-like material. This was very different from what was observed for the samples collected by authors VP and AHG during a 2011 visit to two nearby secondary sapphire deposits at Kochipadana and Ittagama. The sapphires from these deposits known since the late 1970s (Zwaan, 1982; Zwaan, 1986) had in all cases fractures and cavities filled with brown to orange staining, which is common in secondary and detrital-type deposits. Based on these observations and the fact that the sapphires do not present any indication of weathering, it seems very likely that this new deposit is a primary-type deposit, but we could not confirm that possibility.



Figure 40. Shown are a suite of rough crystals from the new Kataragama deposit, four of which were integrated into GIA's research collection. The smallest stone shown weighs approximately seven carats.

The sapphires from the new find are notable for their size. We saw several large sapphire specimens, the largest weighing close to 150 grams (see Figure 41). The stone had numerous fissures but hosted several gem-quality areas of fine color.

Visiting the mining site and the homes of local people around Kataragama we heard several accounts of larger stones, and on the mobile phone of one of the local villagers we were shown photos of a sapphire crystal reportedly weighing about 300 grams (Figure 42). That stone had an interesting story, as it has been reportedly found on the road construction site by one person running to escape from the police on February 14, 2012. While fleeing the miner hit a rock and fell down, and when he

checked the cause of his misadventure he found that it was a large sapphire crystal. True story or rumor? We will probably never know...



Figure 41: Large sapphire crystal weighing approximately 300 carats, reportedly mined near Kataragama and seen in Colombo. Photo: V. Pardieu / GIA Laboratory Bangkok



Figure 42: This sapphire weighs approximately 300 grams and was reported to have been found by a Kataragama villager while trying to escape from the police on February 14, 2012. Photo: an unidentified illegal miner in Kataragama.

Unfortunately, the material from the new deposit near Kataragama is often very included with graphite-, mica-, and feldspar-like inclusions and numerous fissures. Nevertheless, highly transparent areas were visible in most of the specimens examined, and thus the author believes that it is reasonable to expect to see clean faceted gems weighing more than 20 carats produced from that new deposit.

Many of the crystals studied will be challenging to cut because quite a few of the stones produced from that new deposit are of the “ottu type,” meaning that they show some fine blue color banding along the crystal faces, with a colorless core (see Figure 98). Some crystals also show bands of minute to coarse particles or silky areas, or both.

Another potential challenge for the cutters is the rather strong dichroism (suggestive of moderate to high iron content) that is also observed in most of the new material. The noticeable greenish blue component that dominates the color appearance perpendicular to the c-axis of the crystals will present difficulty to the cutters who work this material if they decide not to cut the table of the stone exactly perpendicular to the c-axis of their rough.



Figure 43. This 15 carat sapphire displays numerous opaque black inclusions. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 44. This sapphire crystal from Kataragama weighs approximately 46 carats. Note the strong color banding and colorless areas following the faces of the hexagonal bipyramid. Also note the numerous unhealed fissures. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 45: A silky sapphire crystal seen near Kataragama. This stone, weighing about 7 carats rough, was integrated into the GIA reference collection. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 46: A sapphire crystal specimen from Kataragama showing the very fine transparency that had impressed many gem miners and merchants when they first saw the new material from Kataragama. Photo: V. Pardieu / GIA Laboratory Bangkok.



Figure 47: A 70 carat sapphire seen near Kataragama presenting some areas of very fine blue color but also in its center some dark brownish silky areas locally referred to as "bronze" or 'chocolate" by sapphire buyers. Photo: V. Pardieu / GIA Laboratory Bangkok.

Several gem merchants we met onsite were excited by such "Kashmir-like" or "Burma-like" new material. As with other recent finds, it seems that a new gem deposit is producing stones that challenge the beauty of stones associated with from classic famous deposits.

At the time of our visit the asking prices were already remarkably high. By the end of our visit we had not been able to see any faceted stones from the deposit, but the combination of strong dichroism, strong color banding, high transparency, and the presence of inclusions will obviously require from the cutters a very high level of expertise for such interesting new material to be properly faceted into fine gems.

According to some reports from gem merchants we met in Colombo, many cutters are afraid to facet the new material as it is reportedly very challenging to facet, and many stones were thus polished into cabochons or were presented for sale as rough.



Figure 48: The flat fragment of a broken sapphire crystal (approximately 20 carats) displays bands of fine blue color alternating with whitish bands of minute particles, and its center is filled with "chocolate" brown silk. Photo: V. Pardieu / GIA Laboratory Bangkok.

SAPPHIRES FROM KATARAGAMA: A PRELIMINARY DESCRIPTION.

MATERIALS AND METHODS

As described in the previous sections, GIA collected a number of samples during its expeditions to the Kataragama locality. For this preliminary report the data for only five stones are summarized (Table 1). The samples were fabricated as optical wafers with two surfaces polished perpendicular to the c-axis of the crystal. Optical path lengths of the wafers were measured with a Mitutoyo Series 395 spherical micrometer with an accuracy of 2 microns.

Table 1: The sapphires from Kataragama that are described in this report.

Reference #	Sample Category	Weight (carats)	Polished optical wafer orientation	Wafer path length	Color
100305162359	E1	10.246	c-axis \perp surfaces	5.808 mm	deep blue / light blue
100305162360	E1	7.726	c-axis \perp surfaces	7.806 mm	deep blue / colorless (milky/silky)
100305161800	B2	0.541	c-axis \perp surfaces	1.443 mm	even light blue
100305162771	B2	1.034	c-axis \perp surfaces	1.091 mm	light blue / colorless
100305162828	B2	0.123	c-axis \perp surfaces	1.111 mm	light blue / colorless

Gemological microscopy was performed on the sapphires from Kataragama using binocular microscopes with magnification ranging from 10 to 70x using both darkfield and brightfield illumination. Other lighting techniques, including the use of flexible fiber optic illumination, were also employed to investigate the internal characteristics of the study specimens. A custom-built horizontal microscope fitted with an immersion cell containing methylene iodide was also used to examine growth and color zoning. Photomicrographs of internal features were captured at up to 180x magnification with a Nikon SMZ 1500 system using darkfield, brightfield, and oblique illumination with a fiber optic light.

Additional data were collected using a variety of analytical techniques. Chemistry was determined using a Thermo ARL Quant'X EDXRF Analyzer and LA-ICP-MS (Thermo X Series II) instrument; ultraviolet-visible-near infrared (UV-Vis-NIR) spectra were collected using an Hitachi U-2900 spectrophotometer (for unpolarized ordinary ray spectra) and a PerkinElmer Lambda 950 spectrophotometer operating with the general purpose optic bench, integrating sphere accessory, and dual polarizers (for polarized spectra); infrared spectra were collected using a Thermo Nicolet 6700 FTIR spectrometer operating with a 6x beam condenser accessory; and Raman spectra were collected using a Renishaw inVia Raman microscope fitted with a 514 nm argon ion laser.

GIA uses two methods to analyze the chemical composition of a sample: energy dispersive X-ray fluorescence (EDXRF) analysis and laser ablation-inductively coupled plasma-mass spectroscopy (LA-ICP-MS). The first method gives qualitative or semi-quantitative information on chemical composition (i.e., what

elements are present, and their approximate concentrations), while the latter method provides a quantitative analysis (i.e., their precise concentrations). For the quantitative chemical analysis of gem ruby and sapphire samples, GIA uses a special set of synthetic corundum reference standards that contain known amounts of particular elements of interest. Analyses of gem corundum and of these standards allow us to calculate how much of an element is present in the gem corundum because we can compare it to the known quantities present in the standard.

Pure corundum (aluminum oxide, Al_2O_3) is colorless, but the presence of either impurity elements (often substituting for aluminum) or defects in the atomic lattice can impart color. The more important impurity elements typically incorporated into corundum include chromium (Cr), titanium (Ti), magnesium (Mg), iron (Fe), vanadium (V), and gallium (Ga).

Certain elements, including beryllium (Be), can also be artificially introduced into corundum through a diffusion process by heating the material at very high temperatures in order to change its color.

Brief description of the reference samples selected and studied:

During GIA FE33 expedition to Kataragama, GIA Laboratory Bangkok Field Gemologist Vincent Pardieu collected 86 corundum samples from 13 different independent sources. The samples cover a wide extent of sizes, colors, clarity and overall quality. This is in compliance with the GIA Laboratory Bangkok protocols requiring that GIA Field gemologists should collect numerous reference samples as close as possible from the mine and from multiple independent sources. All the samples were properly documented in Bangkok according to GIA field gemology department protocols.

The information collected in the field was confirmed by a brief study of all these samples at the GIA laboratory Bangkok. It was found that the internal and external aspect of these stones, collected from different independent sources, had enough similarities and specificities to validate that they were probably coming from a single source and had not been submitted to any treatment.

After that preliminary control study, GIA Laboratory Bangkok research gemologists selected five samples collected on March 08th 2012 from 4 different independent sources to collect spectroscopic and chemical data for this preliminary study. The samples were fabricated as wafers in Bangkok in order to collect quality optical data to be used as reference for GIA gemologists.

Besides these 5 samples, a selection of 22 other corundum samples was fabricated in order to study their inclusions. The inclusions in these stones were photographed and a selection of these photos is presented in this study in "The internal world of Kataragama sapphires" in the page 45 of that report.

Specimen 100305162359

GIA reference sample 100305162359 (Figure 49) is an E1 type sample (see Annex C) collected on March 8th 2012 from a miner/gem merchant near Kataragama who obtained him reportedly from a local miner working on the road-building site. It's color range from deep to light blue color. It is angular zoned with weak to medium blue color saturation (Figure 50 and Figure 51). The specimen weighs 10.246 carats and is particularly transparent.

Twinning is present in this specimen (Figure 52), something that is unusual in Sri Lankan blue sapphires we have observed previously. Minute particles with a milky appearance were noted in colorless areas, while coarser particles were noted over some blue areas (Figure 50 and Figure 51).

Polarized UV-Vis-NIR spectra (ordinary and extraordinary rays) were collected for the specimen using the PerkinElmer Lambda 950. The beam path was free of any visible inclusions and of the twin planes. The recorded spectra (Figure 53) show a UV cutoff at 306 and 307 nm, and a distinct band at 330 nm from pairs of trivalent iron (Fe^{3+}). Other trivalent iron features were observed: the 377 nm line (Fe^{3+} pairs), 388 nm line (isolated Fe^{3+} ions), and 450 nm line (Fe^{3+} pairs) are clear. The overall line shapes of the spectra are similar to that which might be expected from some blue sapphires from Sri Lanka or Madagascar and certainly from Burma (Myanmar).

The infrared spectrum collected for this stone was recorded through a deep blue area. The only feature recorded was at 3309 wavenumbers (cm^{-1} ; Figure 54).

When viewed under long-wave and short-wave ultraviolet (UV) light no reaction was observed, apart from a small area (outside the beam paths for the spectroscopic data) with a weak to medium orange fluorescence under long-wave UV light.

The LA-ICP-MS chemical data (Table 2) were collected on each side of the specimen (eight spots total) on areas that appeared weak blue and did not contain particulate inclusions. For each spot between 1 and 4 parts per million atomic (ppma) of Ti was available (after subtracting out the Ti paired with the available Mg) to pair with Fe in a charge-transfer reaction that produces the blue coloration; this estimate corresponds with the visual observation of color and confirms that the analyzed elemental concentrations are reasonable.



Figure 49: Several views of GIA reference sample 100305162359 (E1 type; see Annex C for a description of the classification system), seen here prior to fabrication and weighing 10.246 carats. The color is deep to light blue. This stone was collected from a miner in Kataragama.

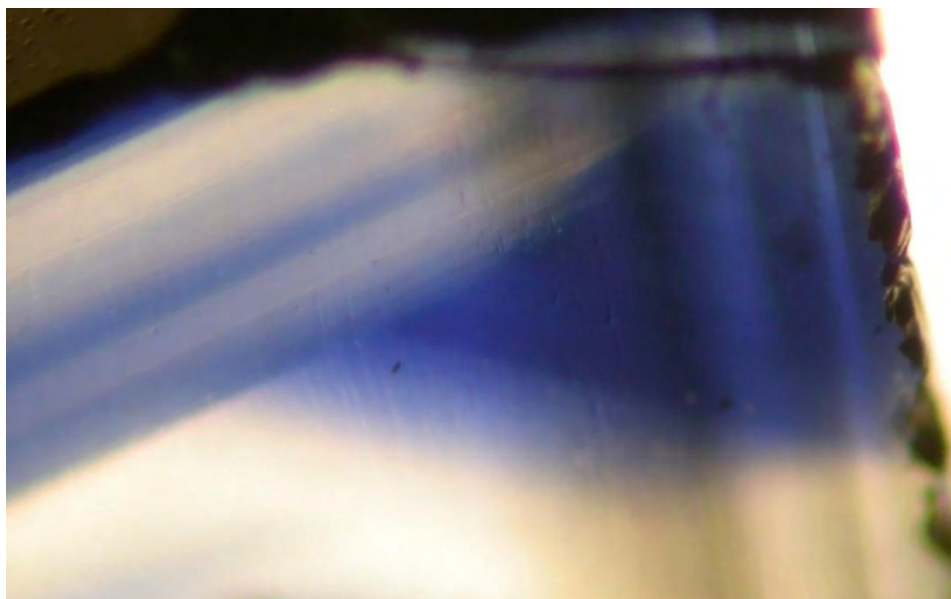


Figure 50: Colorless and blue areas within GIA reference sample 100305162359. Brightfield illumination, magnified 50x.

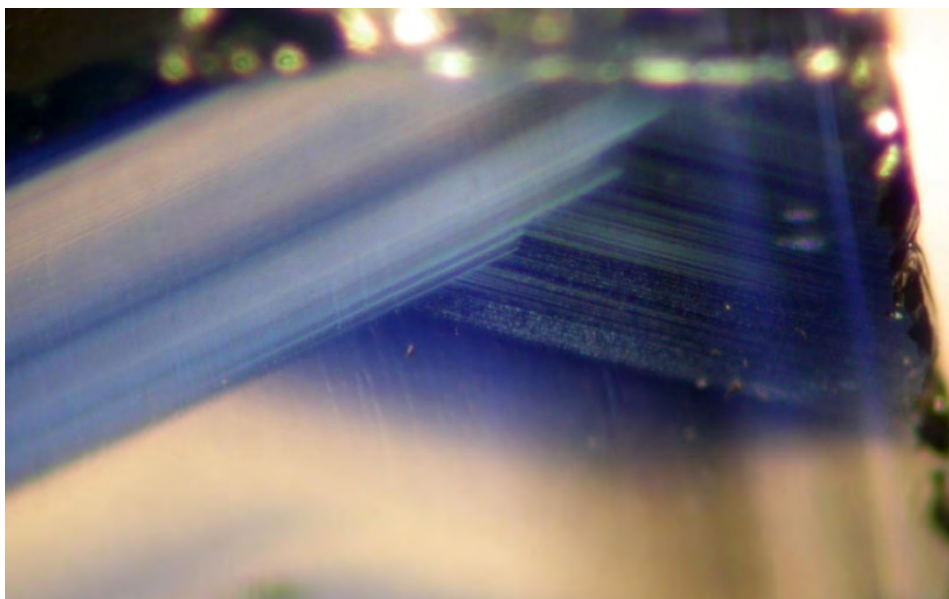


Figure 51: The colorless areas on left are associated with milky bands of minute particles within GIA reference sample 100305162359. Coarser particles are seen over the blue area on right. Brightfield plus fiber optic illumination, magnified 50x.

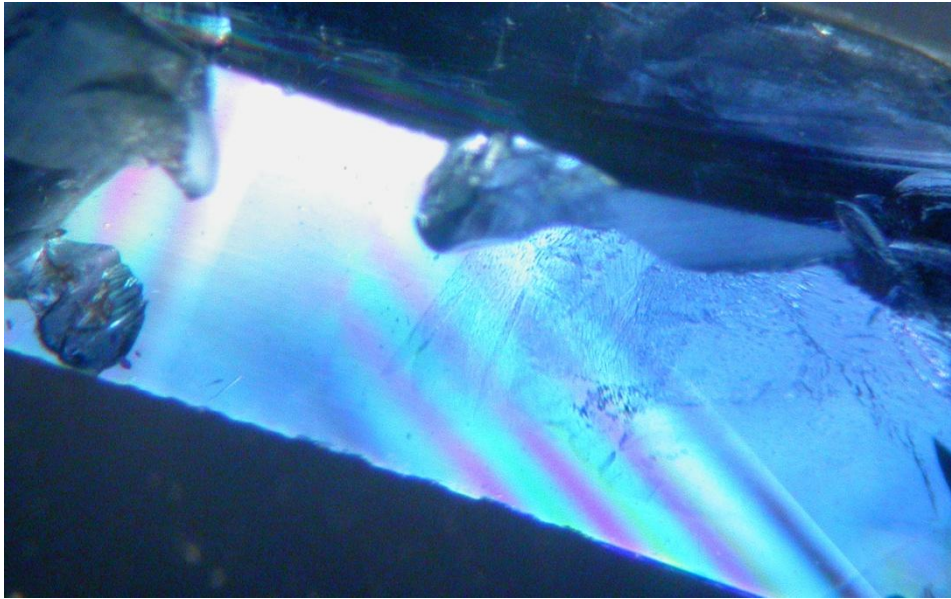


Figure 52: Twinning planes within GIA reference sample 100305162359. Cross-polarized light, magnified 30x.

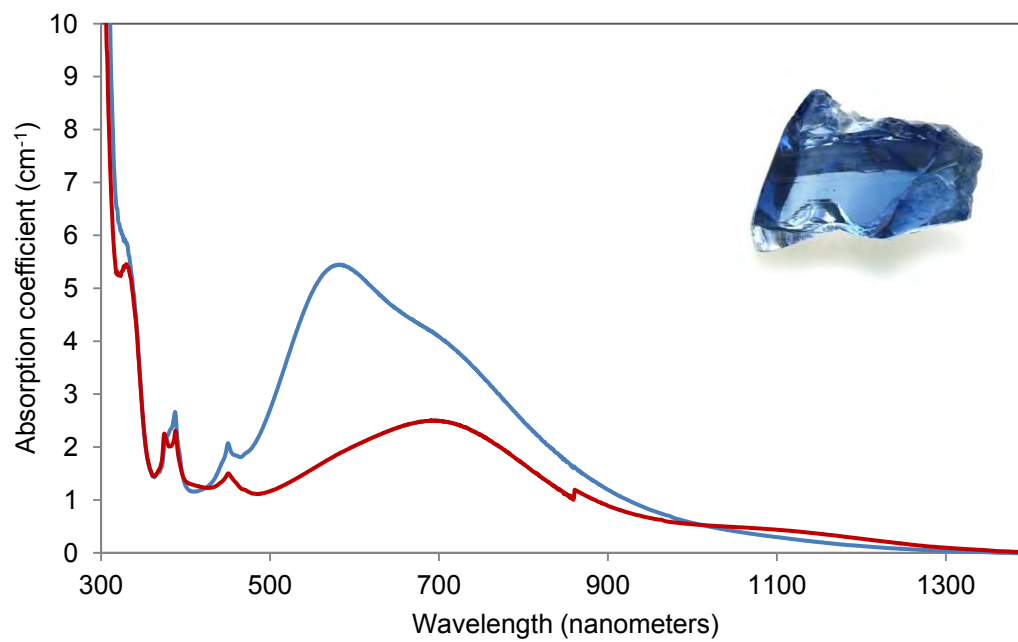


Figure 53: Polarized UV-Vis-NIR absorption spectra of GIA reference sample 100305162359. Ordinary ray shown in blue, and extraordinary ray shown in red. Optical path length: 5.808 mm. Weight: 10.246 carats. Color: Deep blue / light blue.

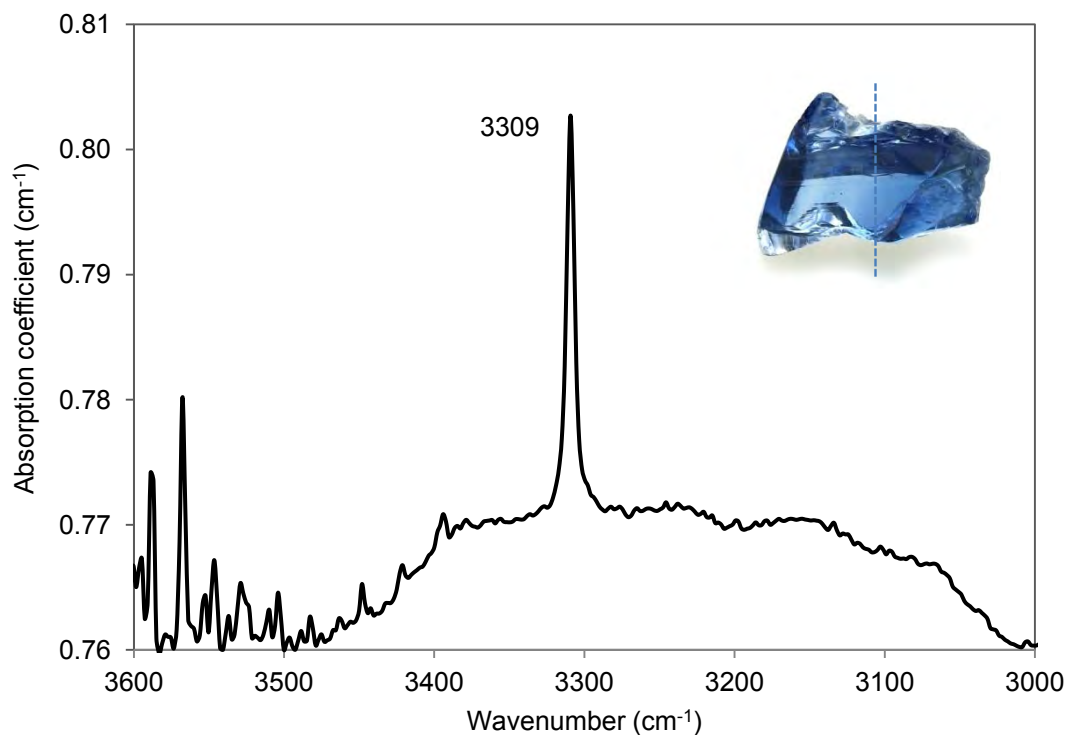


Figure 54: FTIR spectrum of GIA reference sample 100305162359. Approximate path length: 5.808 mm. Weight: 10.246 carats, Color: Deep blue / light blue.

Table 2: LA-ICP-MS chemical data for GIA reference sample 100305162359. Note: bdl for "below detection limit".

Specimen 100305162359	Concentration (PPMA)						
	Be	Mg	Ti	V	Cr	Fe	Ga
Spot 1	bdl	20.05	23.34	4.60	bdl	580.54	9.71
Spot 2	bdl	17.45	21.47	4.60	bdl	551.33	9.51
Spot 3	bdl	15.69	19.76	4.12	bdl	540.38	8.69
Spot 4	bdl	19.54	20.44	4.80	bdl	565.94	9.30
Spot 5	bdl	14.76	16.78	4.00	bdl	562.29	8.13
Spot 6	bdl	16.86	19.89	4.92	bdl	591.50	8.54
Spot 7	bdl	14.68	16.23	4.52	bdl	569.59	8.48
Spot 8	bdl	15.77	20.44	4.72	bdl	562.29	8.51

Specimen 100305162360

GIA reference sample 100305162360 (Figure 55) is an E1 type sample (see Annex C) collected on March 8th 2012 from a miner/gem merchant near Kataragama who obtained him reportedly from local people mining on the road-building site. It has a deep blue / colorless (milky / silky) appearance. It is angular zoned with weak to medium blue color saturation (Figure 56 and Figure 57). The specimen weighs 7.726 carats and is particularly transparent.

Bands of minute particles and needles are associated with colorless areas (Figure 56 and Figure 57), and negative crystals are present along with naturally healed fissures (Figure 59 and Figure 58).

The beam path used for the UV-Vis and FTIR data was free of any visible inclusions. The recorded polarized spectra from the PerkinElmer Lambda 950 (Figure 60) show a UV cutoff at 306 and 307 nm and a distinct band at 330 nm. The 377, 388, and 450 nm lines are clear; the overall line shapes of the spectra are similar to that which might be expected from some blue sapphires from Sri Lanka or Madagascar and certainly from Burma (Myanmar). The spectra also resemble those collected for specimen 100305162359 (Figure 53).

The infrared data show two distinct features at 3309 and 3161 wavenumbers (cm^{-1} ; Figure 61).

When viewed under long-wave and short-wave UV light no reaction was observed, except for a weak to medium orange fluorescence reaction in the colorless areas when the specimen was observed under long-wave.

The LA-ICP-MS chemical data (Table 3) were collected from both colorless and blue areas of the specimen (eight spots total), spots 1 to 4 were from the colorless areas on the top and spots 5 to 8 were from light blue areas on the bottom. The data for spots 1 to 4 (colorless areas) showed Mg concentrations that were greater than those for Ti, and in the blue areas the Ti exceeded the Mg concentrations, leaving between 1 and 3 ppm of Ti to pair with the available Fe to produce the apparent blue color.



Figure 55: Several views of GIA reference sample 100305162360 (E1 type; see Annex C), seen here prior to fabrication and weighing 7.726 carats. The color is deep blue / colorless (milky / silky). The specimen was collected from a miner in Kataragama.

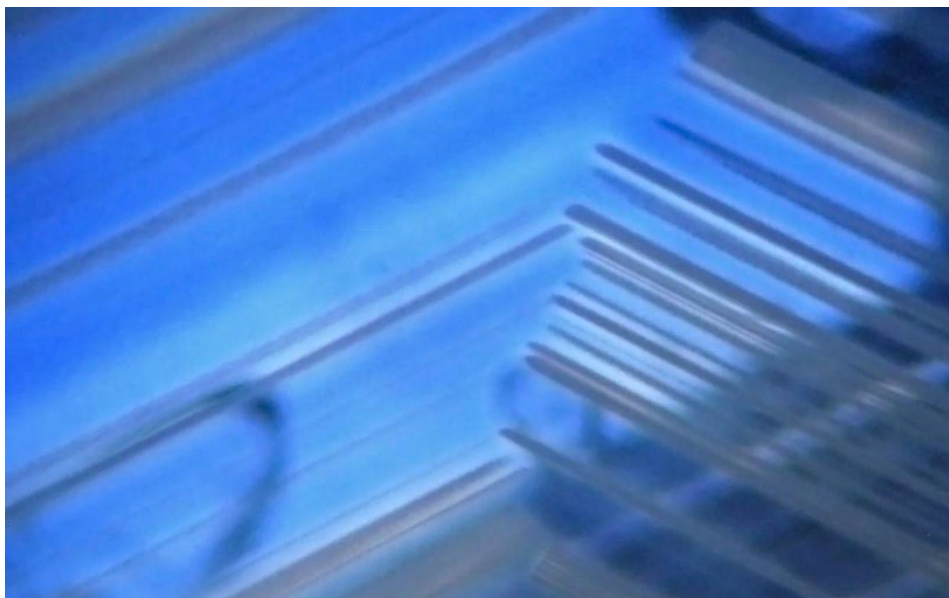


Figure 56: Bands of minute particles and needles associated with colorless areas within GIA reference sample 100305162360. Brightfield illumination, magnified 30x.

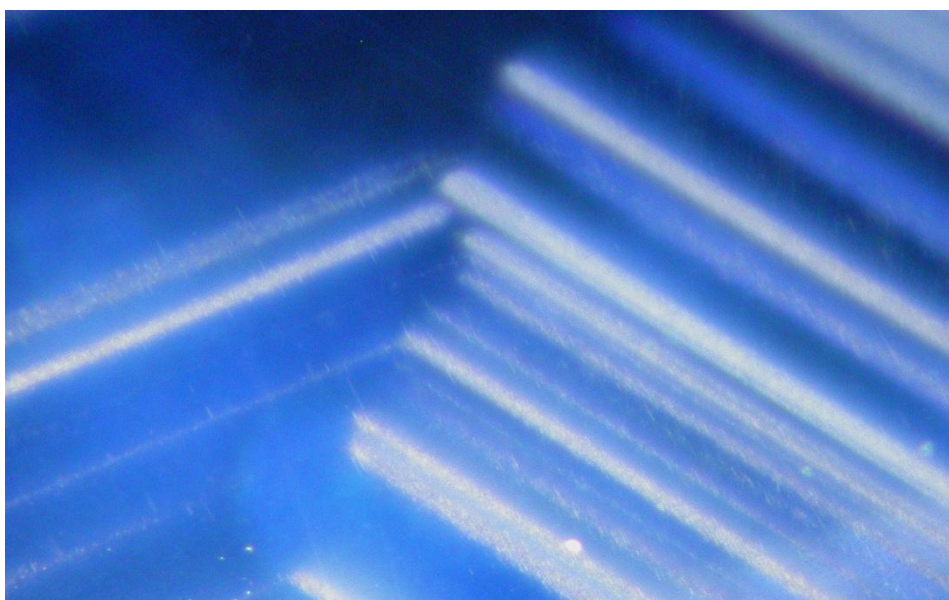


Figure 57: Bands of minute particles and needles associated with colorless areas within GIA reference sample 100305162360. Fiber optic illumination, magnified 50x.



Figure 59: Negative crystal within GIA reference sample 100305162360. Darkfield illumination, magnified 50x.



Figure 58: Negative crystals and healed fissure within GIA reference sample 100305162360. Darkfield illumination, magnified 50x.

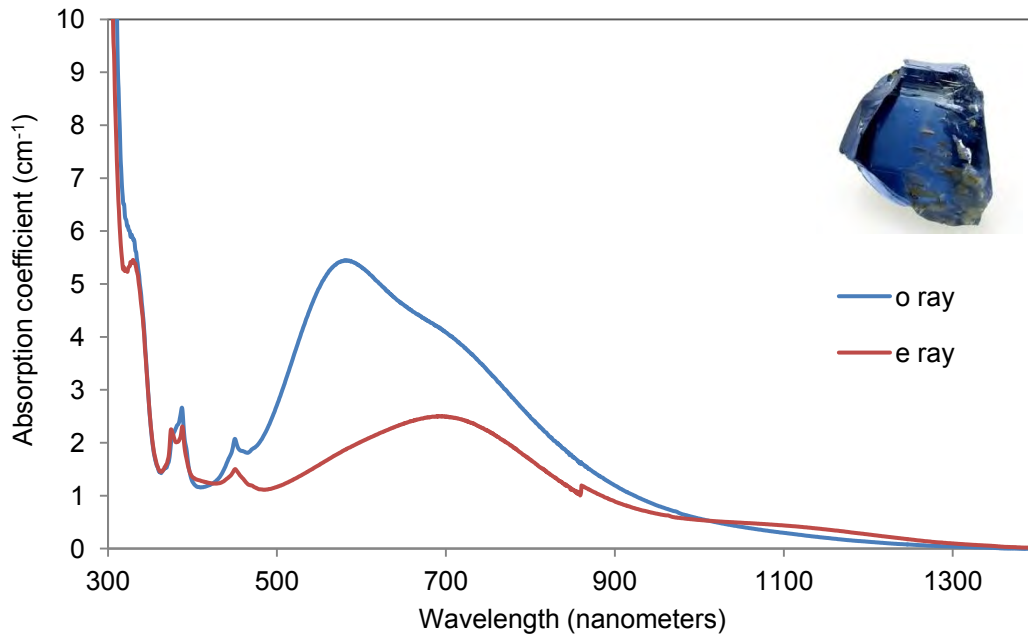


Figure 60: Polarized UV-Vis-NIR absorption spectra of GIA reference specimen 100305162360. Optical path length: 7.806 mm. Weight: 7.726 carats. Color: angular zoned with weak to medium blue.

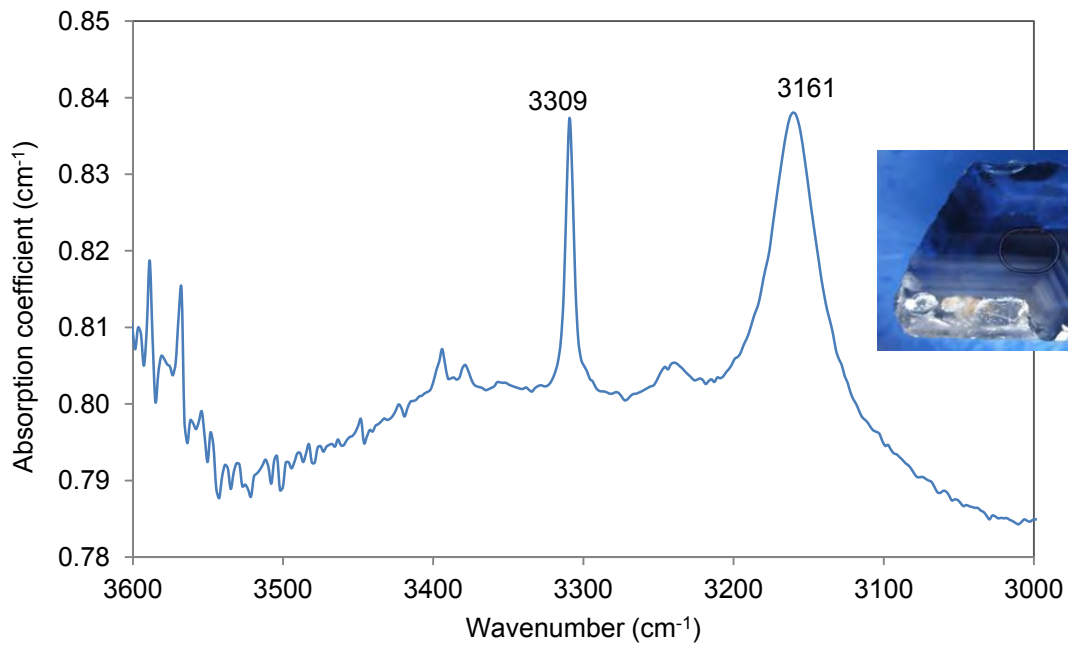


Figure 61: FTIR spectrum of GIA reference specimen 100305162360. Approximate path length: 7.806 mm. Weight: 7.726 carats. Color: Weak to medium blue with angular zoning.

Table 3: LA-ICP-MS chemical data for specimen 100305162360. Note bdl for "below detection limit"

Specimen 100305162360	Concentration (PPMA)						
	Be	Mg	Ti	V	Cr	Fe	Ga
Spot 1	bdl	14.34	10.26	4.44	bdl	507.52	14.04
Spot 2	bdl	12.75	10.56	4.84	bdl	558.63	14.57
Spot 3	bdl	13.17	9.63	4.08	bdl	522.12	14.13
Spot 4	bdl	13.67	11.12	4.52	bdl	533.08	14.19
Spot 5	bdl	9.98	12.95	4.56	bdl	565.94	15.36
Spot 6	bdl	11.49	14.95	4.56	bdl	587.84	15.74
Spot 7	bdl	11.24	14.44	4.80	bdl	598.80	15.50
Spot 8	bdl	10.65	12.05	5.00	bdl	613.40	15.97

Specimen 100305161800

GIA reference sample 100305161800 is a B2 type sample collected on March 08th 2012 from a villager mining the road construction site. The weight is 0.541 carats and the color is a quite even light blue.

The UV-Vis-NIR absorption data were collected with the Hitachi U-2900 for this sample. The beam path used for data collection passed through a lightly saturated blue area. The path did not contain any visible particles, twinning planes, or other inclusions.

The FTIR spectrum shows a very weak feature at 3309 wavenumbers.

The stone showed a weak orange reaction under long-wave UV light on a small area out of the beam path.

The LA-ICP-MS data were collected on both sides of the wafer in the same area as the UV-Vis measurement beam path. For this sample all ten data points were collected on areas that appeared to be light blue in color and did not contain any particles.

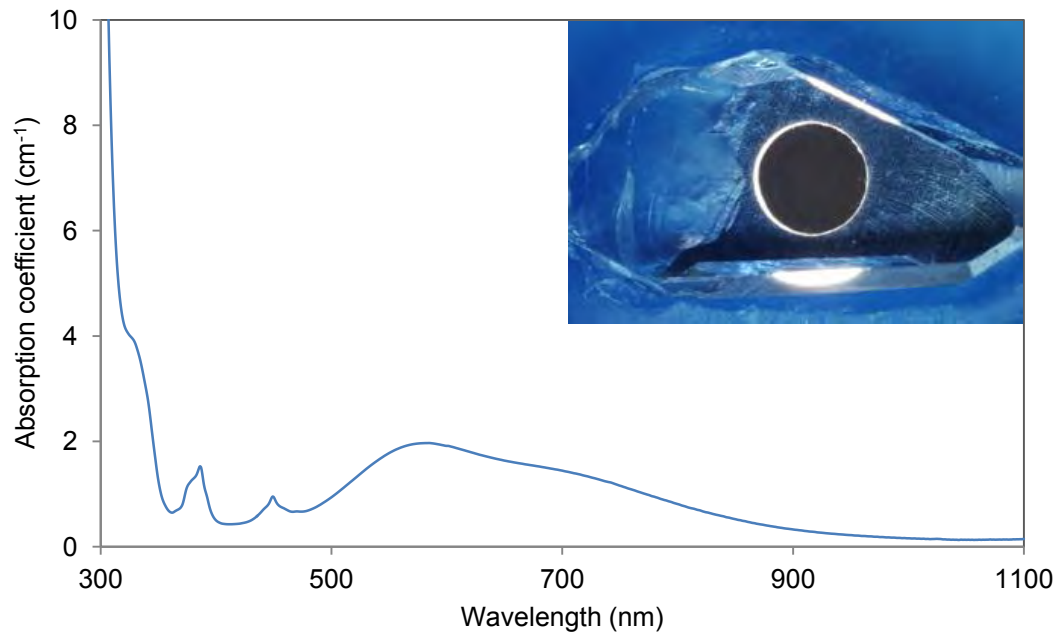


Figure 62: The UV-Vis-NIR ordinary ray spectrum of specimen 100305161800, with photo of beam area (inset). Optical path length: 1.443 mm.

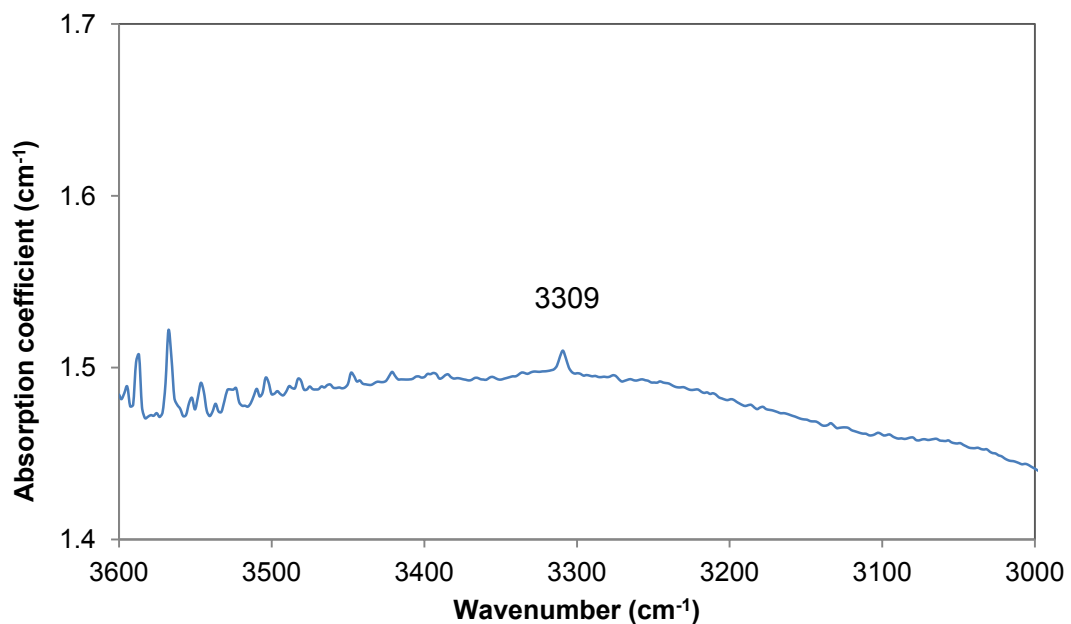


Figure 63: FTIR spectrum of GIA reference specimen 100305161800. Approximate path length: 1.443 mm. Weight: 0.541 carats. Color: Even light blue.

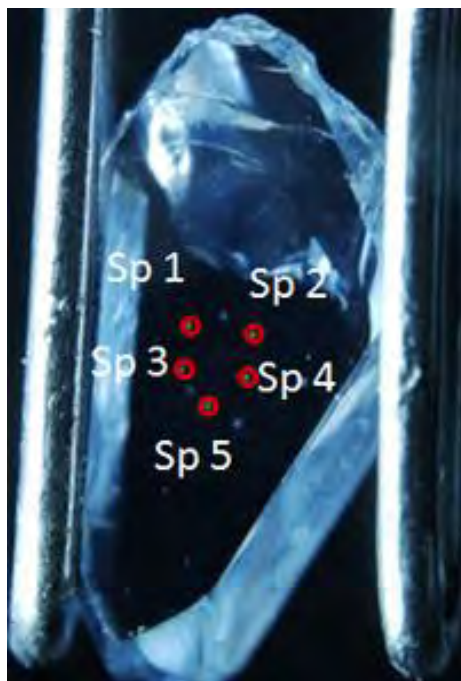


Figure 65: Five spots where LA-ICP-MS chemical data were obtained on the front of wafer sample 100305161800. See Table 4.

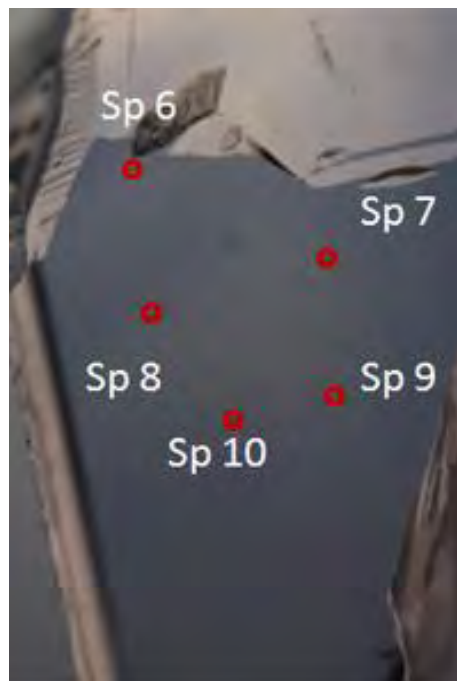


Figure 64: Five spots where LA-ICP-MS chemical data were obtained on the back of wafer sample 100305161800. See Table 4.

Table 4: LA-ICP-MS chemical data obtained from the front (spots 1-5) and the back (spots 6-10) of wafer sample 100305161800. Note: bdl for "below detection limit"

Specimen 100305161800	Concentration (PPMA)						
	Be	Mg	Ti	V	Cr	Fe	Ga
Spot 1	bdl	17.20	14.57	3.75	27.14	507.52	8.80
Spot 2	bdl	14.68	15.97	3.56	bdl	525.77	9.30
Spot 3	bdl	11.16	13.33	3.63	bdl	525.77	9.33
Spot 4	bdl	12.16	14.86	3.95	bdl	529.43	8.86
Spot 5	bdl	12.75	13.50	3.80	bdl	514.82	8.72
Spot 6	bdl	12.58	10.35	3.49	16.39	485.61	8.42
Spot 7	bdl	12.25	12.01	3.84	bdl	518.47	9.01
Spot 8	bdl	11.58	12.65	4.16	bdl	562.29	9.36
Spot 9	bdl	14.18	17.04	4.00	bdl	544.03	8.80
Spot 10	bdl	16.11	17.16	4.32	bdl	606.10	9.01

Specimen 100305161771

GIA reference sample 100305161771 is a B2 type sample collected on March 08th 2012 from a villager mining the road construction site. The weight is 1.034 carats and the color is light blue to colorless.

The UV-Vis-NIR absorption data were collected with the Hitachi U-2900 for this sample. The beam path used for data collection passed through a lightly saturated blue area. The path contained a few visible weak milky band associated with the blue color areas.

The FTIR spectrum shows a very weak feature at 3309 wavenumbers.

The stone had no reaction under either long-wave or short-wave UV radiation.

The LA-ICP-MS data were collected on both sides of the wafer in the same area as the UV-Visible measurement beam path. For this sample all eight data points except #5 and #7 (which were collected on colorless zones) were on areas that appear to be light blue.

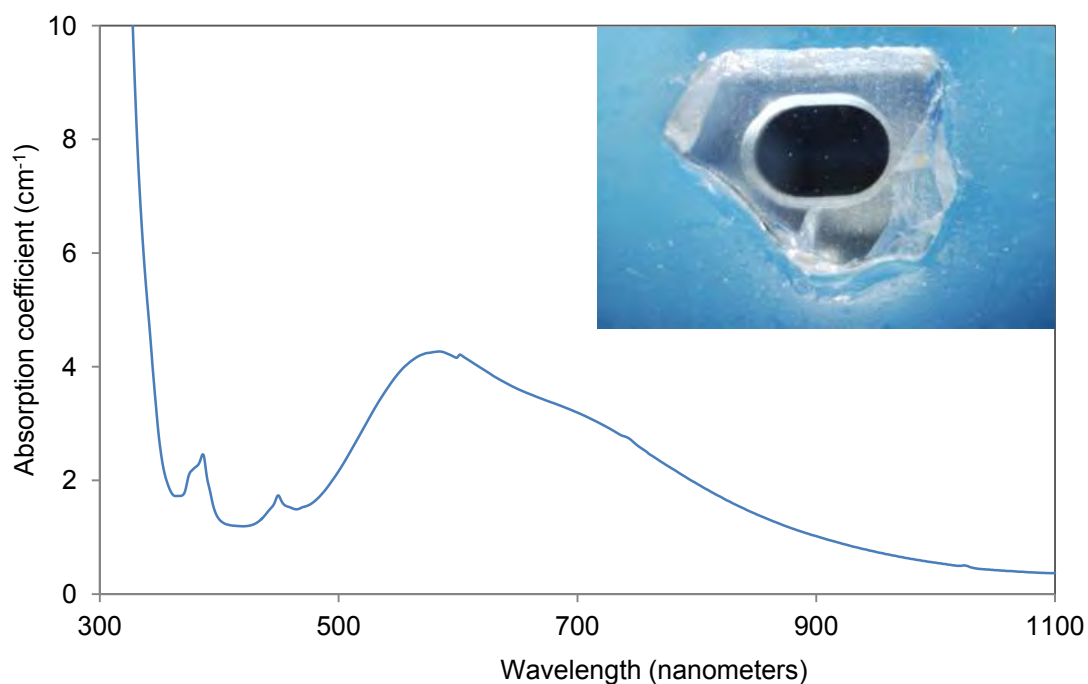


Figure 66: The UV-Vis-NIR ordinary ray spectrum of specimen 100305161771, with photo of beam area (inset). Optical path length: 1.091 mm.

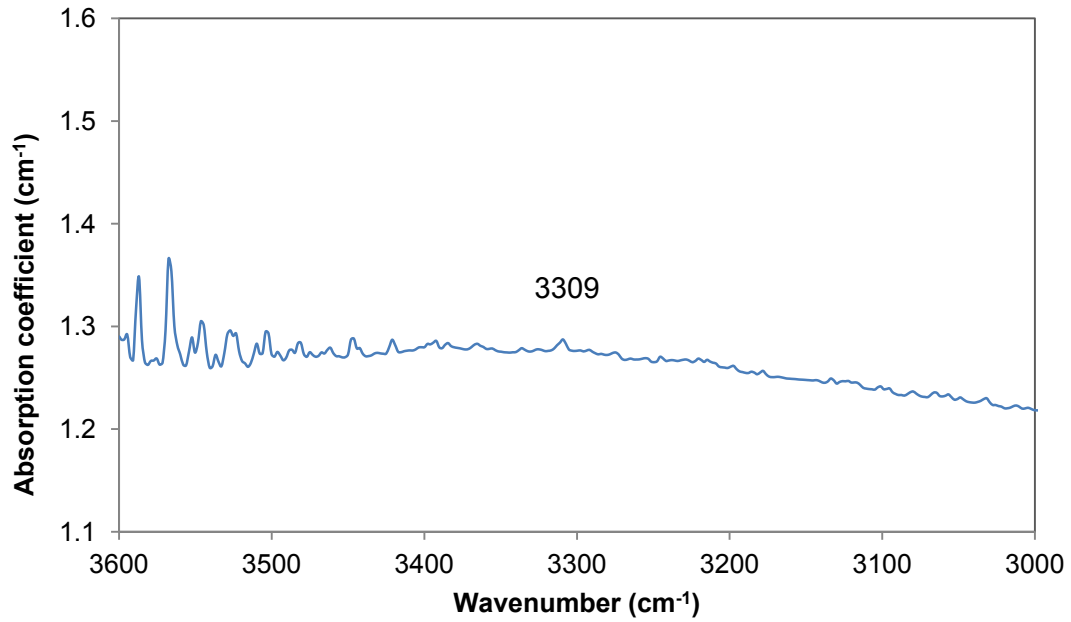


Figure 67: FTIR spectrum of GIA reference specimen 100305161771. Approximate path length: 1.091 mm. Weight: 1.034 carats. Color: Light blue and colorless.



Figure 68: Four spots where LA-ICP-MS chemical data were obtained on the front of the wafer sample 100305161771. See Table 5.



Figure 69: Four spots where LA-ICP-MS chemical data were obtained on the back of the wafer sample 100305161771. See Table 5.

Table 5: LA-ICP-MS chemical data obtained from the front (spots 1-4) and the back (spots 5-8) for wafer sample 100305161771. Note: bdl for "below detection limit"

Specimen 100305161771	Concentration (PPMA)						
	Be	Mg	Ti	V	Cr	Fe	Ga
Spot 1	bdl	23.99	63.88	8.53	bdl	613.40	20.65
Spot 2	bdl	20.22	40.59	6.61	bdl	595.15	14.13
Spot 3	bdl	22.48	66.87	7.69	bdl	613.40	20.65
Spot 4	bdl	21.64	40.84	6.57	bdl	562.29	14.04
Spot 5	bdl	9.98	9.97	4.56	bdl	481.96	9.24
Spot 6	bdl	20.80	54.51	7.69	bdl	565.94	18.54
Spot 7	bdl	10.07	10.05	4.52	bdl	525.77	9.42
Spot 8	bdl	22.98	60.05	8.69	bdl	617.05	18.31

Specimen 100305161828

GIA reference sample 100305162828 is a B2 type sample collected on March 08th 2012 from a villager mining the road construction site. The weight is 1.123cts and the color is light blue to colorless.

This tiny wafer (3mm by 3mm) was fabricated from the same rough as GIA reference specimen 100305161771. The UV-Vis-NIR absorption data were collected with the Hitachi U-2900 for this sample. The beam path used for data collection passed through a slightly milky (containing minute particles) lightly saturated blue area.

The FTIR spectrum showed no features in the region of interest (~3000-3600 wavenumbers).

The stone showed no reaction under long-wave or short-wave UV radiation.

The LA-ICP-MS data were collected on both sides of the wafer in the same area as the UV-Visible measurement beam path. In this case: spots 1 to 4 were taken on a thin weak blue band containing particles, spot 5 was taken in a colorless area and spot 6 to 8 were taken in light blue areas containing few particles.

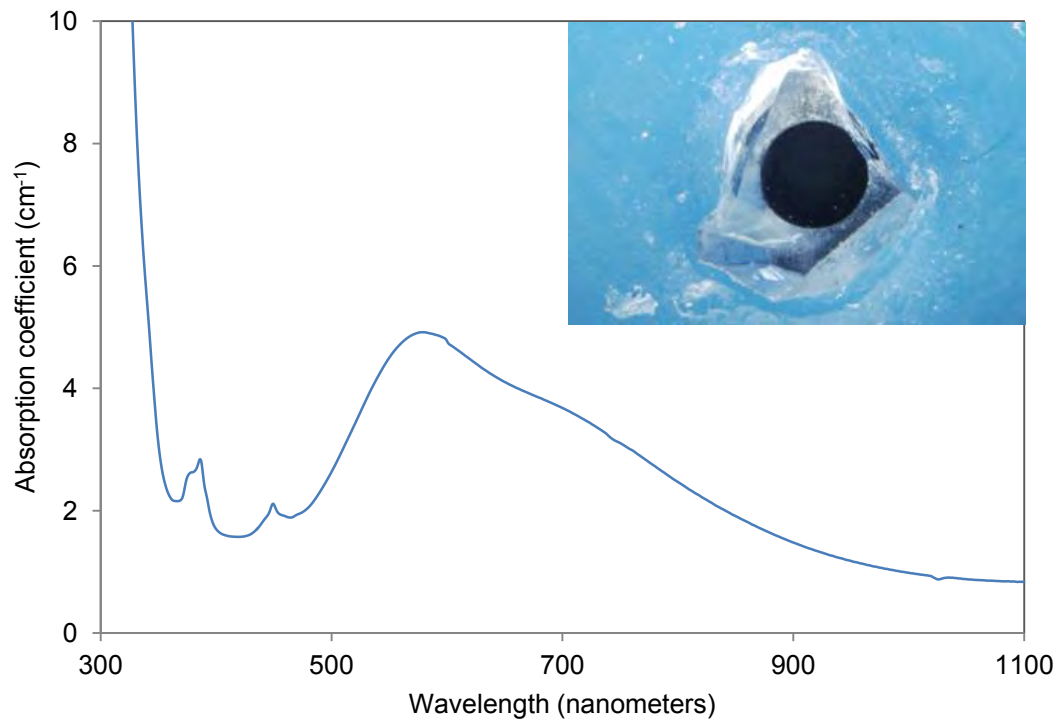


Figure 70: The UV-Vis-NIR ordinary ray spectrum of specimen 100305161828, with photo of beam area (inset). Optical path length: 1.111 mm.

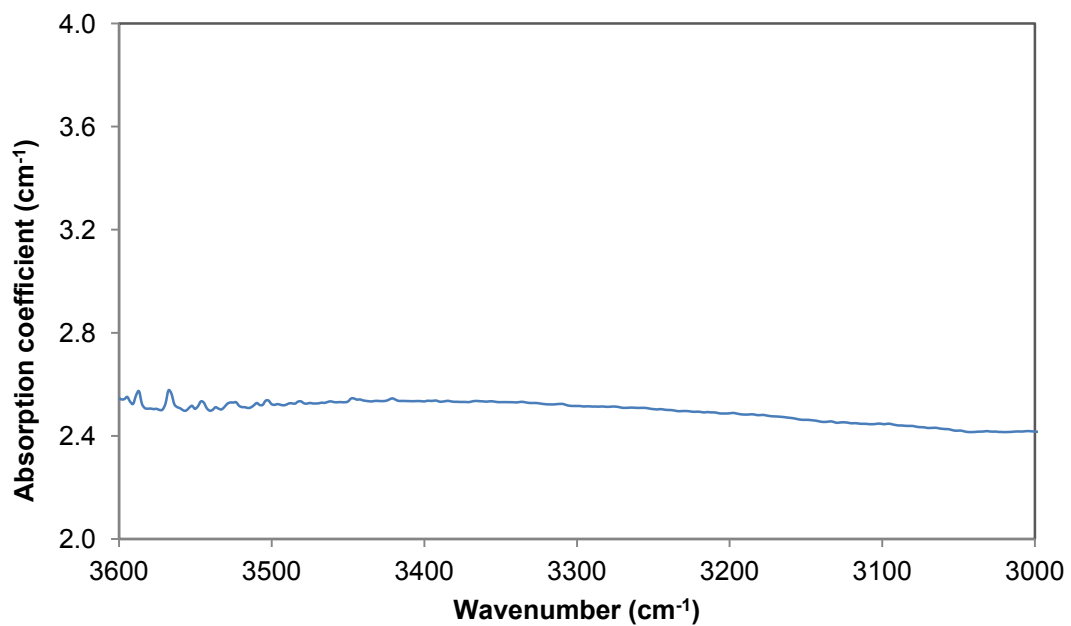


Figure 71: FTIR spectrum of GIA reference specimen 100305161828. Approximate path length: 1.111 mm. Weight: 0.123 carats. Color: Light blue and colorless.



Figure 72: Four spots where LA-ICP-MS chemical data were obtained on the front of the wafer sample 100305161828. See Table 6.



Figure 73: Four spots where LA-ICP-MS chemical data were obtained on the back of the wafer sample 100305161828. See Table 6.

Table 6: LA-ICP-MS chemical data obtained from the front (spots 1-4) and the back (spots 5-8) for wafer sample 100305161828.

Specimen 100305161828	Concentration (PPMA)						
	Be	Mg	Ti	V	Cr	Fe	Ga
Spot 1	bdl	23.40	33.13	6.65	25.29	544.03	17.52
Spot 2	bdl	22.15	38.59	6.77	bdl	584.19	16.85
Spot 3	bdl	21.64	46.00	7.05	bdl	595.15	17.96
Spot 4	bdl	23.24	49.83	7.17	bdl	628.01	16.91
Spot 5	bdl	7.02	6.39	4.68	23.02	412.59	15.24
Spot 6	bdl	22.98	52.81	7.09	bdl	606.10	19.27
Spot 7	bdl	13.67	26.83	6.41	bdl	518.47	18.92
Spot 8	bdl	23.32	48.98	7.81	bdl	595.15	18.25

The internal world of Kataragama sapphires

A microscopic study of the internal features seen in a large volume of this new material revealed many inclusions commonly seen in sapphires from classic Sri Lankan deposits in and around Ratnapura. Some unusual features were also noted.

Strong blue to colorless color zoning, as seen in these new gems, is not unusual in Sri Lanka sapphires; e.g., in ottu-type specimens where the blue color is only present on the rim of the sapphire crystal while the core of the specimen is colorless. Such features, in addition to the dichroism, present a serious challenge for gem cutters.

Besides strong color zoning, the new material also hosts many mineral inclusions, as well as healed and unhealed fissures, as is commonly the case with stones from primary-type deposits. Open unhealed fissures were observed in many specimens, as were healed fissures with well-developed fingerprint-like appearances.

The most frequent mineral inclusions seen in these new Kataragama sapphires are graphite platelets, mica crystals, dark green spinel, zircons, negative crystals (filled commonly with CO₂ liquid / gas), and uraninite-like crystals. We were able to conclusively identify several biotite mica and green spinel crystals near the surface of rough crystals using Raman spectroscopy. Based on comparison of the morphologies of the analyzed inclusions with those in other samples, we are confident in our identification of mica and spinel inclusions in samples for which we were not able to collect analytical data.

The sapphires commonly host also many different types of minute particles and needles (probably rutile), but also sometimes hematite- or ilmenite-type platelets. The minute particles and needles are usually seen forming bands and planes commonly oriented parallel to the prisms or to the basal pinacoid. The needles present may be short or long and thin; the short ones usually form dense bands or planes while the long thin ones are typically more loosely scattered inside the stones.

Finally many of these sapphires also contained twin planes, which is an uncommon feature for Sri Lankan sapphires.

The following figures are intended to provide a general overview of the types of inclusions encountered in sapphires from Kataragama.

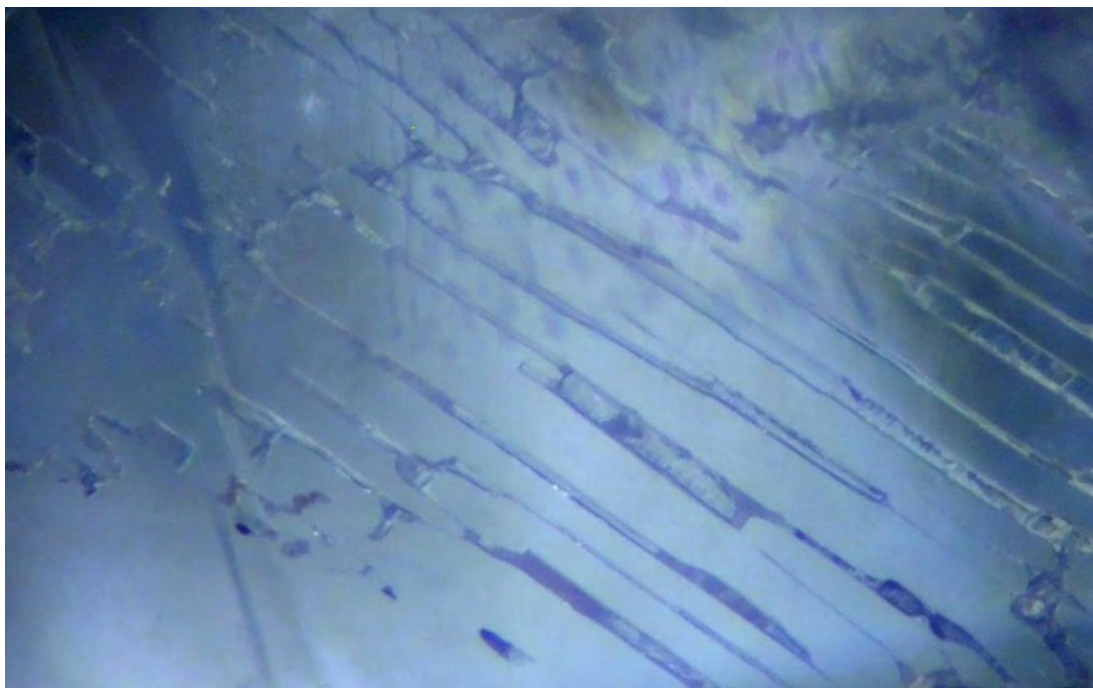


Figure 74: Healed fissures. Darkfield illumination, magnified 50x.

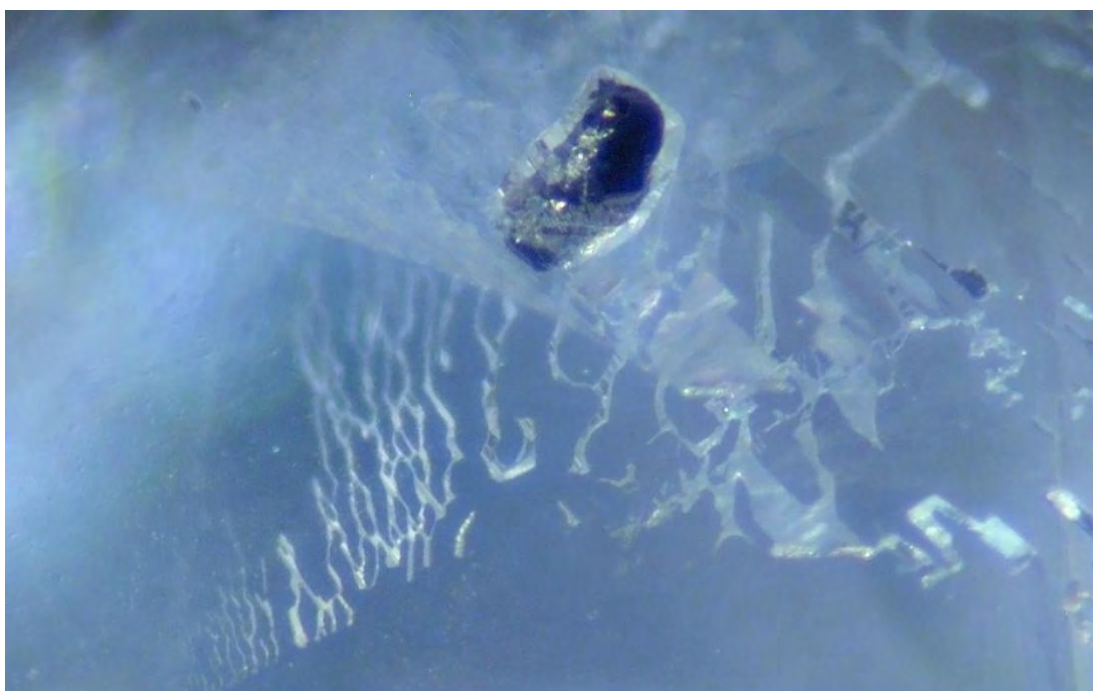


Figure 75: Black high-luster crystal and negative crystal-like healed fissures. Darkfield and fiber optic illumination, magnified 30x.

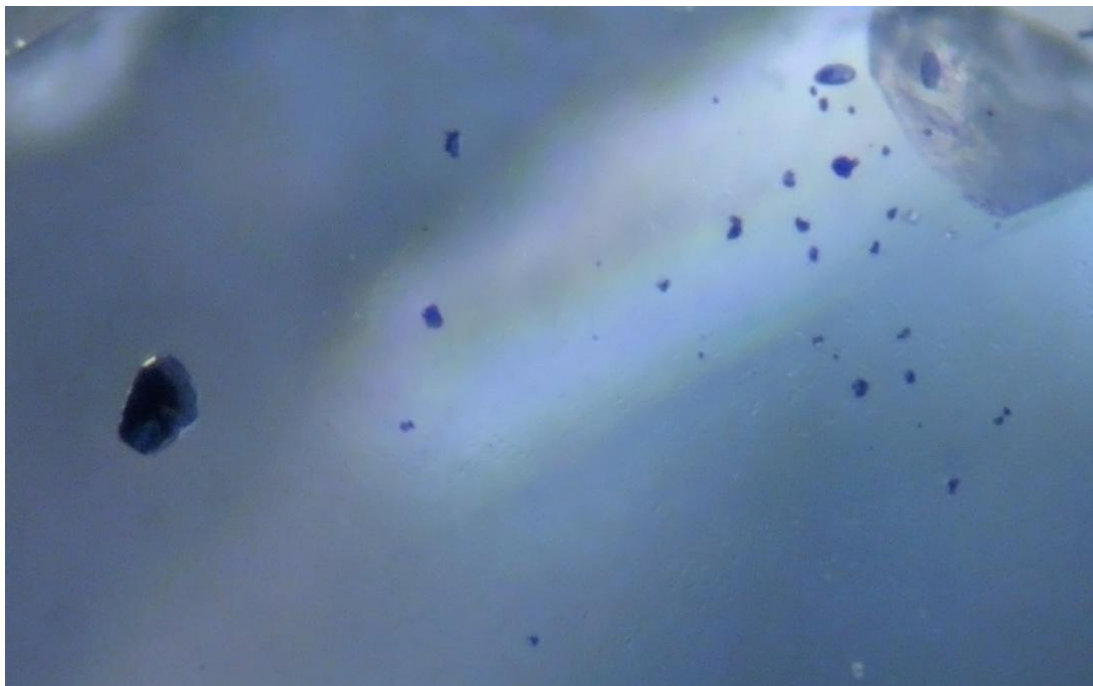


Figure 76: Small graphite-like crystals. The larger crystal at left is likely spinel, based on morphological similarity to a spinel inclusion identified with Raman spectroscopy in another sample. Darkfield illumination, magnified 50x.

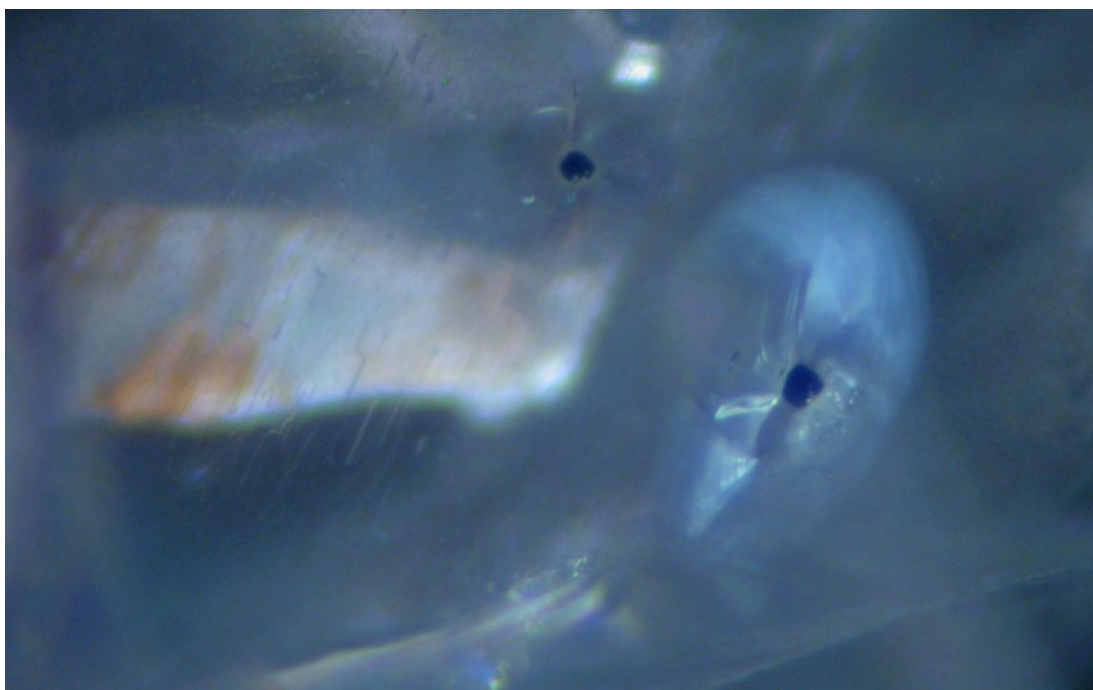


Figure 77: Dark opaque crystals associated with unhealed tension fissures. Darkfield illumination, magnified 50x.

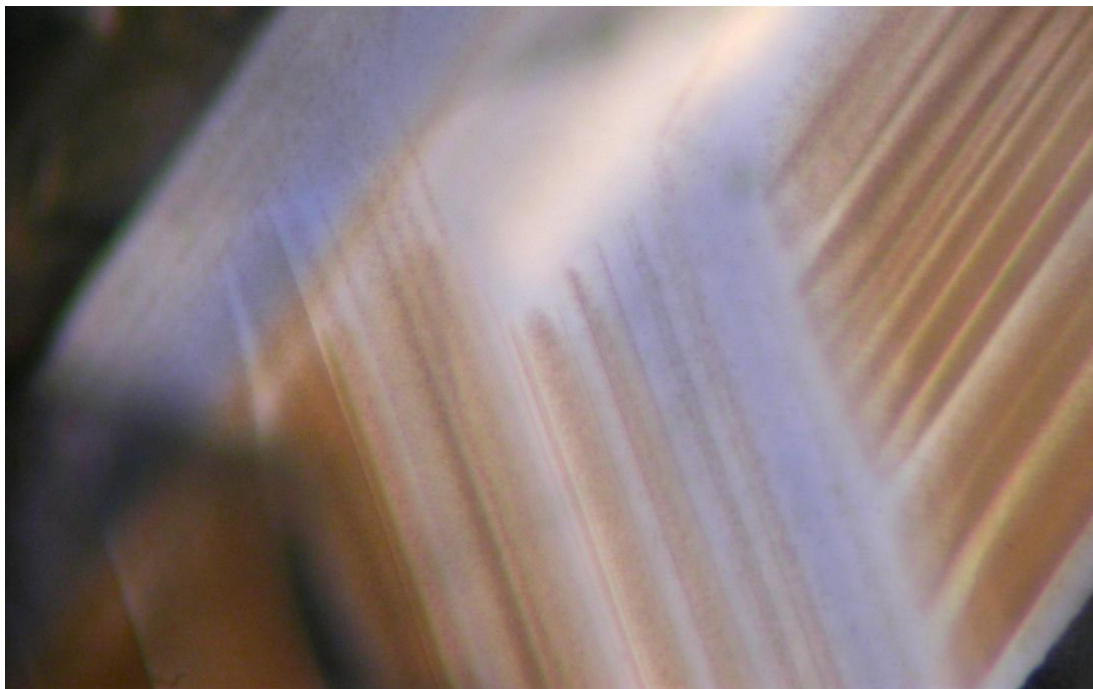


Figure 78: Bands of minute particles associated with colorless areas. Brightfield illumination, magnified 30x.

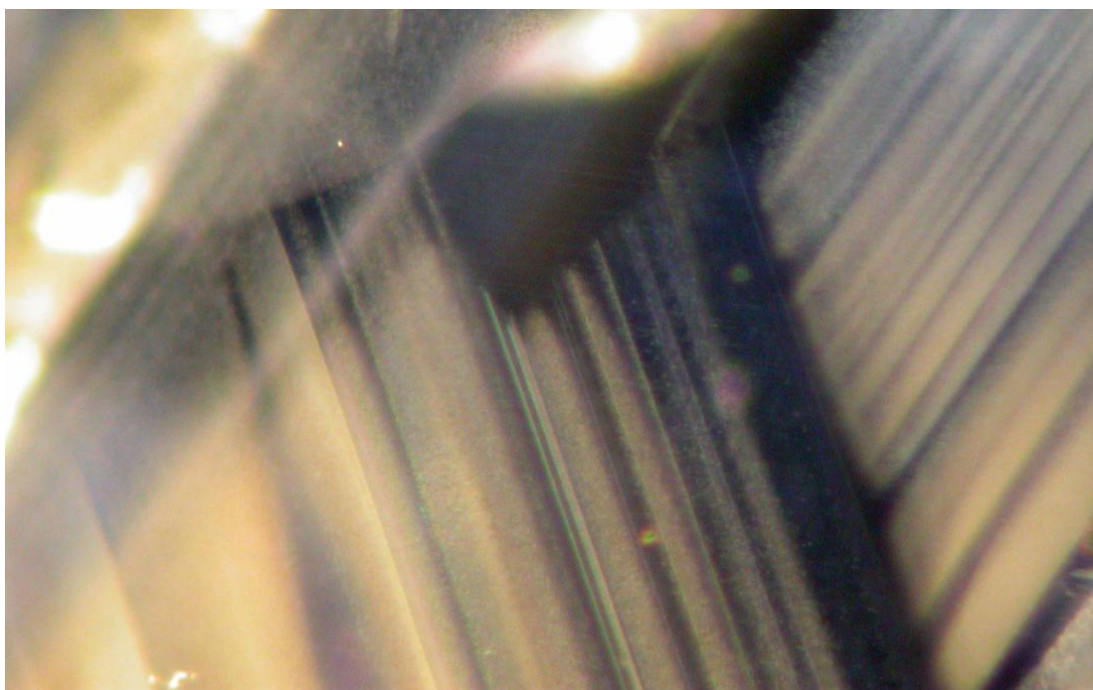


Figure 79: Bands of minute particles associated with colorless areas. Darkfield illumination, magnified 30x.

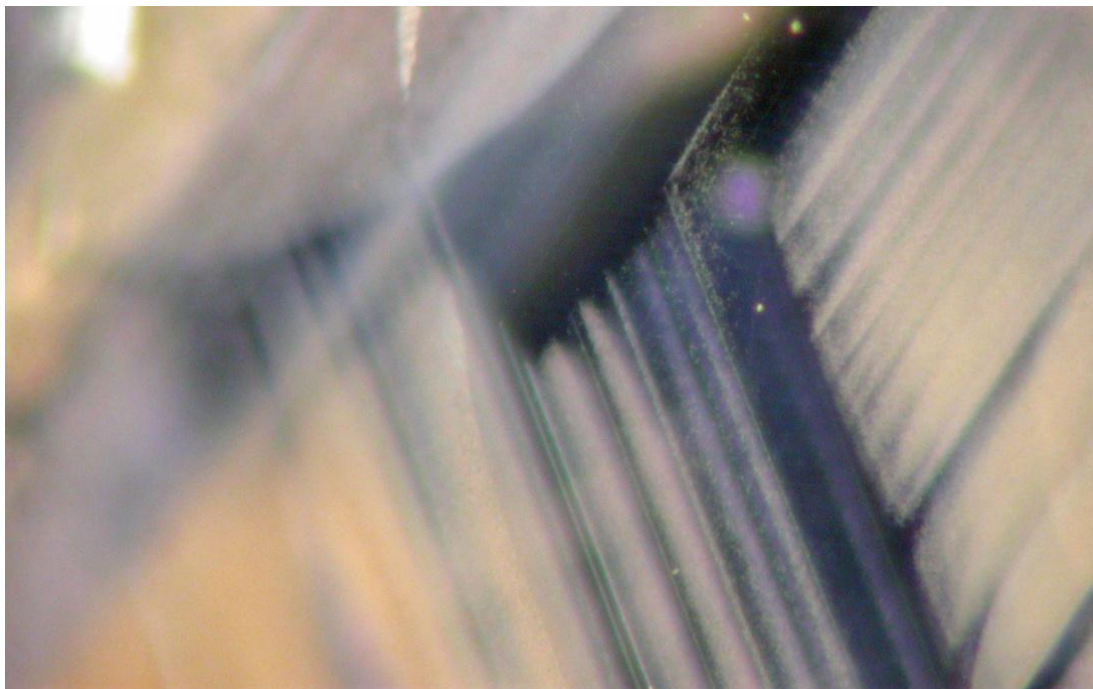


Figure 80: Bands of minute particles associated with colorless areas. Fiber Optic Illumination, 30x

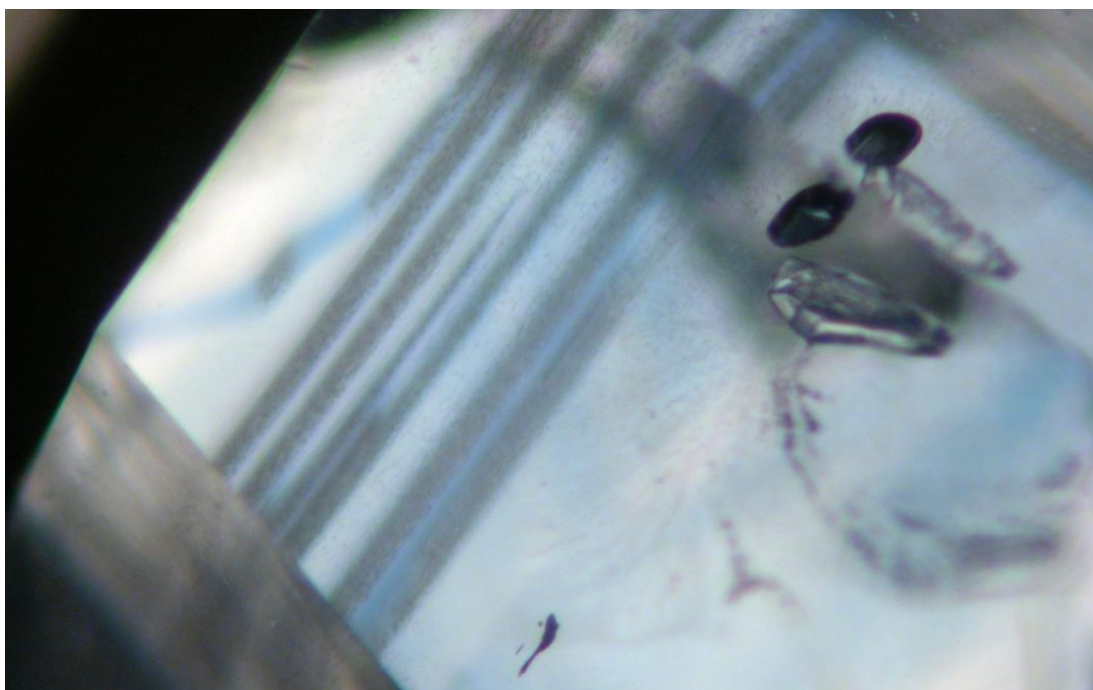


Figure 81: Bands of minute particles that appear to be associated with blue areas. Brightfield illumination, magnified 30x.

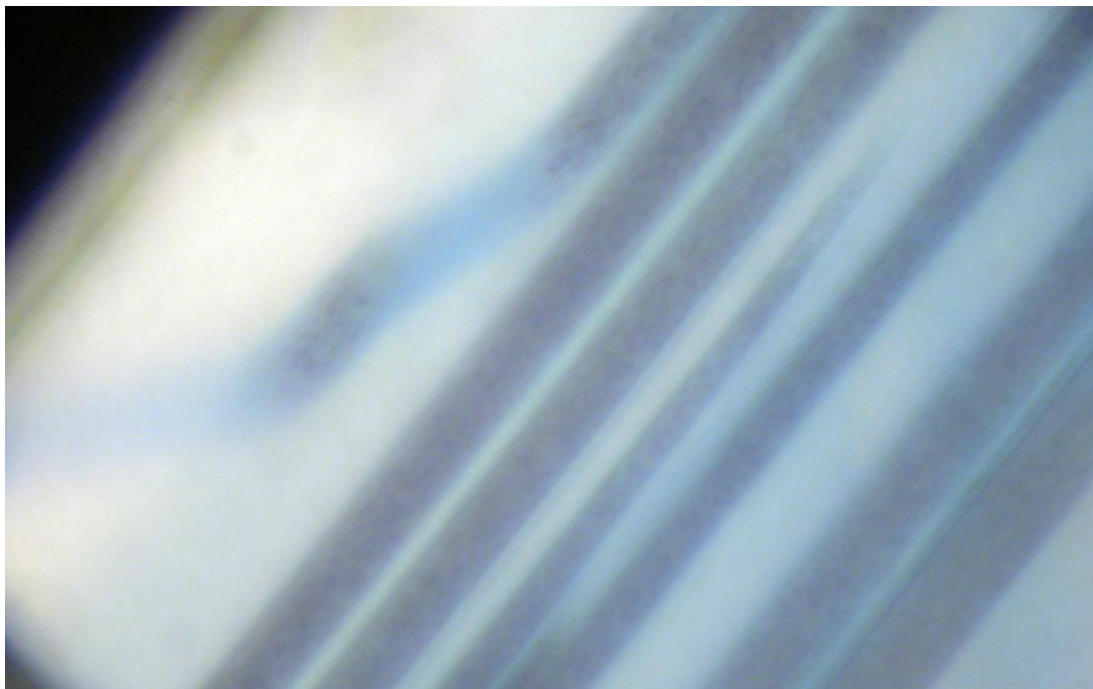


Figure 82: When viewed perpendicular to the c-axis, these particles appear to be associated with blue areas. Brightfield illumination, magnified 60x.



Figure 83: Negative crystal, graphite platelet, and particles and needles. Darkfield and fiber optic illumination, magnified 50x.



Figure 84: When viewed along the direction of the c-axis: the deep blue-colored area is near the surface, while the particles are located in the colorless center. Brightfield illumination, magnified 30x.

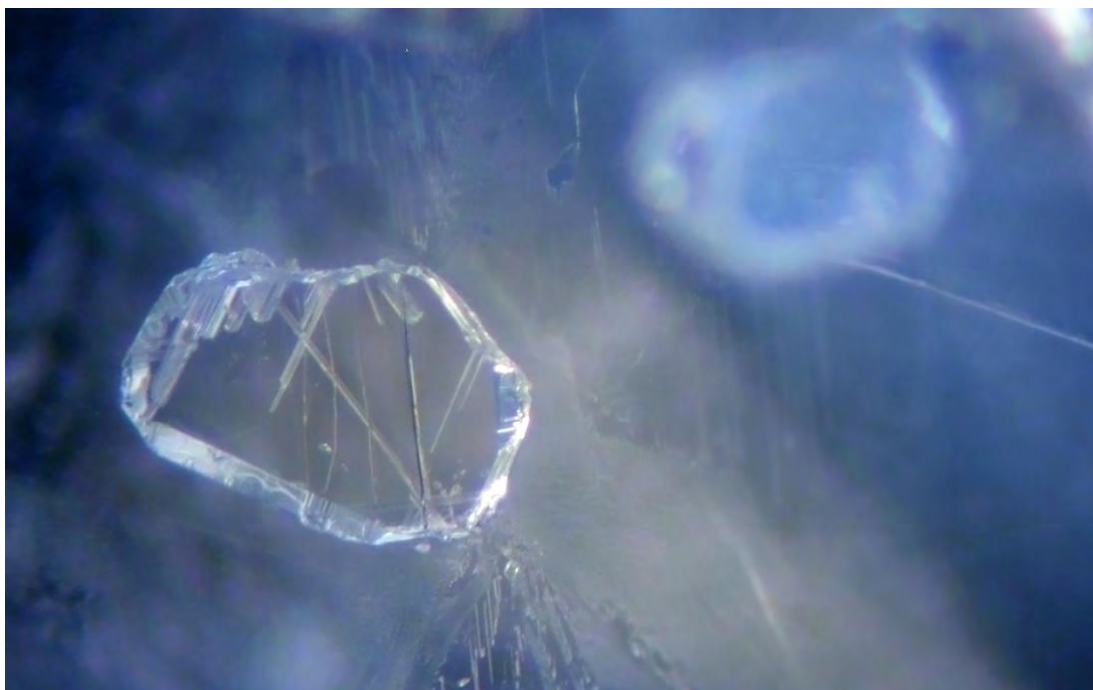


Figure 85: Negative crystal hosting needle-shaped crystals that are probably diaspore. Darkfield illumination, 30x magnification.

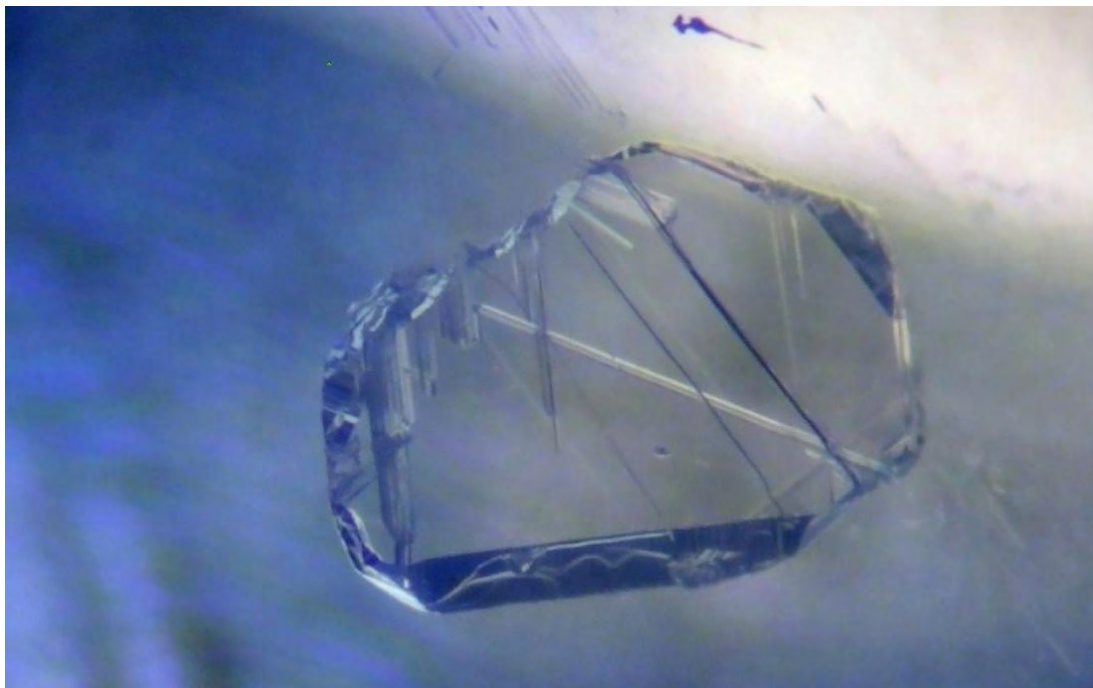


Figure 86: A detailed of the negative crystal shown in the previous image (Figure 85). Brightfield illumination, magnified 60x.

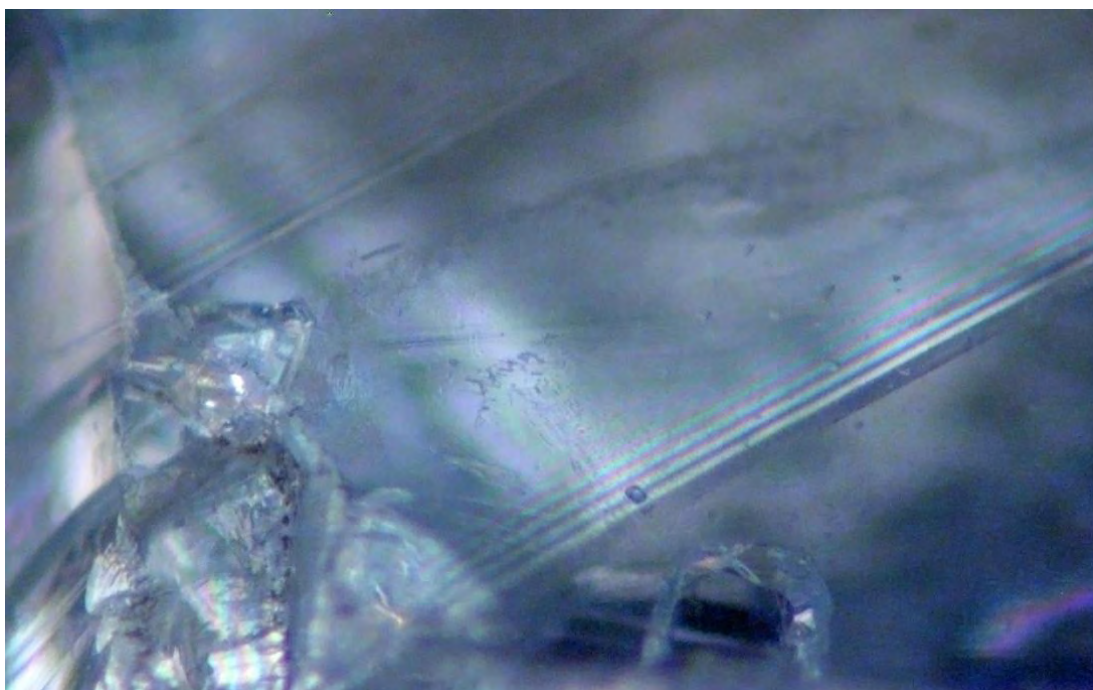


Figure 87: Twinning planes. Cross-polarized light, magnified 40x.

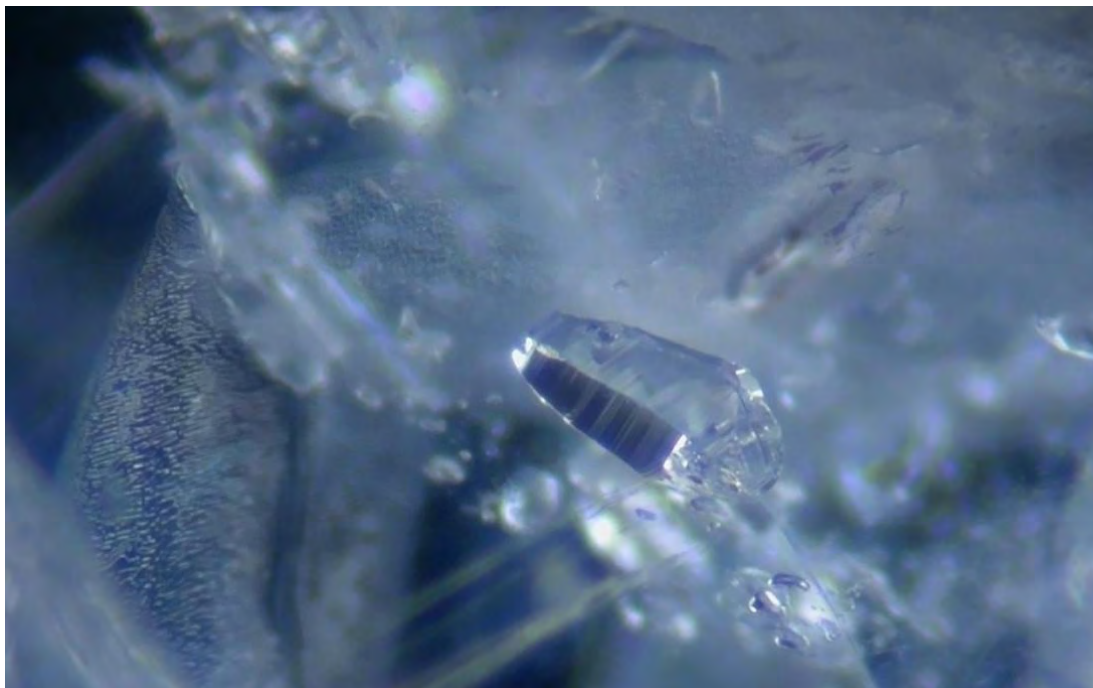


Figure 88: Negative crystal associated with healed fissures. Darkfield illumination, magnified 50x.

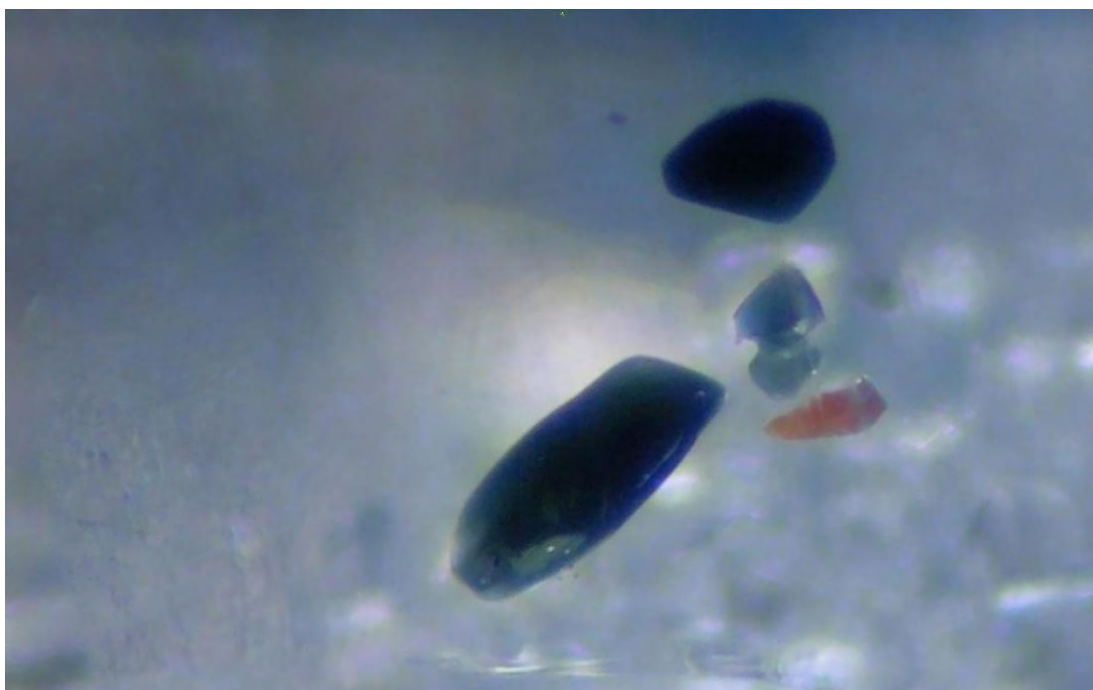


Figure 89: Black low-luster dark green spinel crystals. Crystals with similar morphologies in were identified as spinel using Raman spectroscopy. Darkfield and fiber optic illumination, magnified 50x.

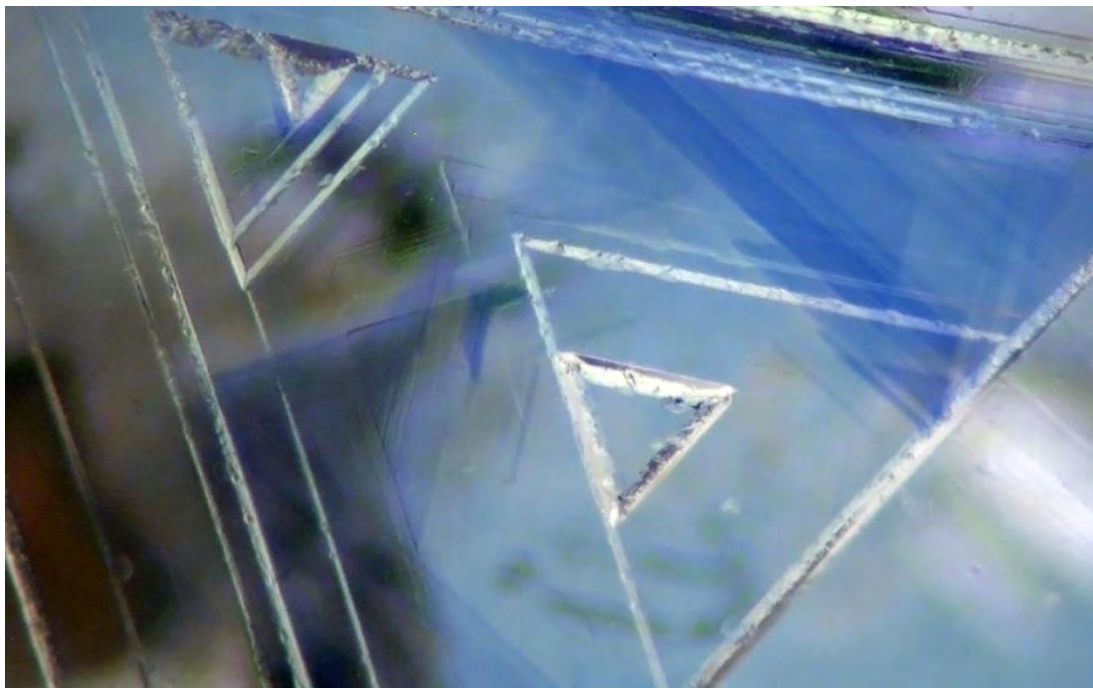


Figure 90: Surface-related thin blue color zoning and growth marks. Darkfield illumination, magnified 30x.

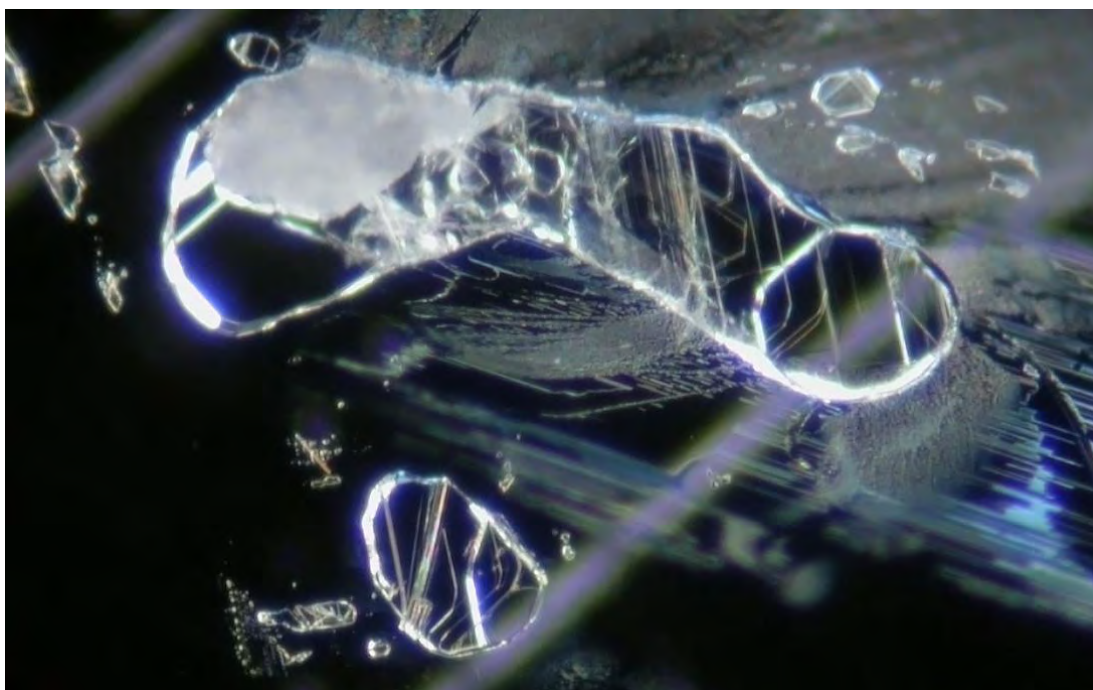


Figure 91: Negative crystals and healed fissures. Darkfield illumination, magnified 50x.

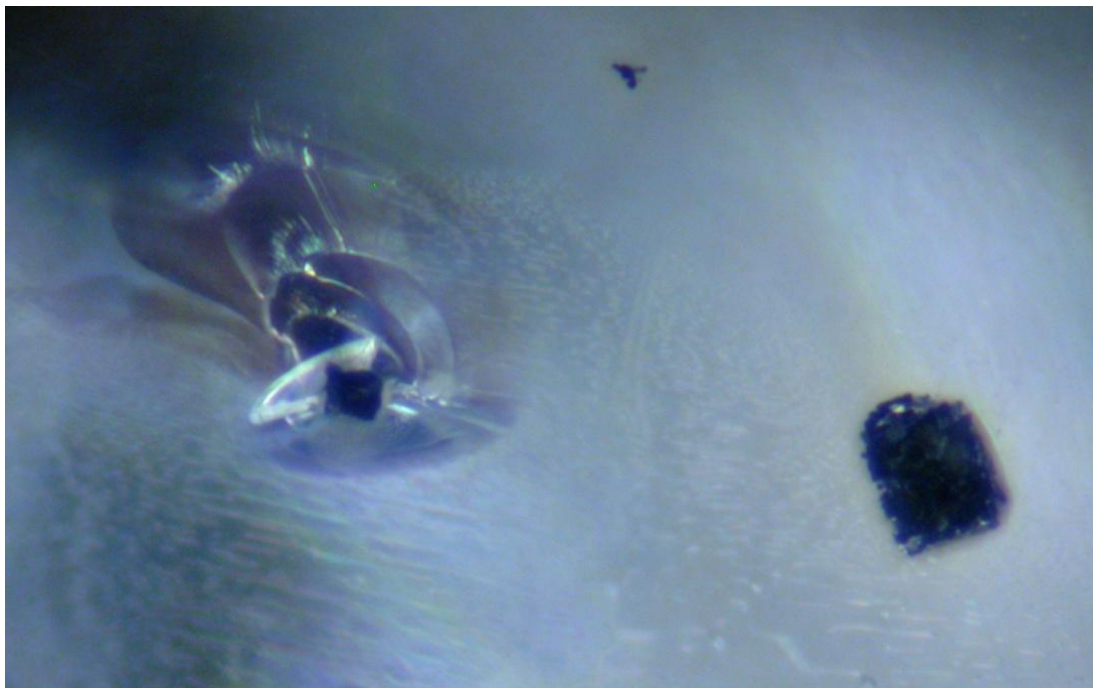


Figure 92: A uraninite-like crystal associated with unhealed tension fissures (left). Also shown is a dark crystal that is morphologically similar to other inclusions that were identified as spinel using Raman spectroscopy. Darkfield illumination, magnified 30x.

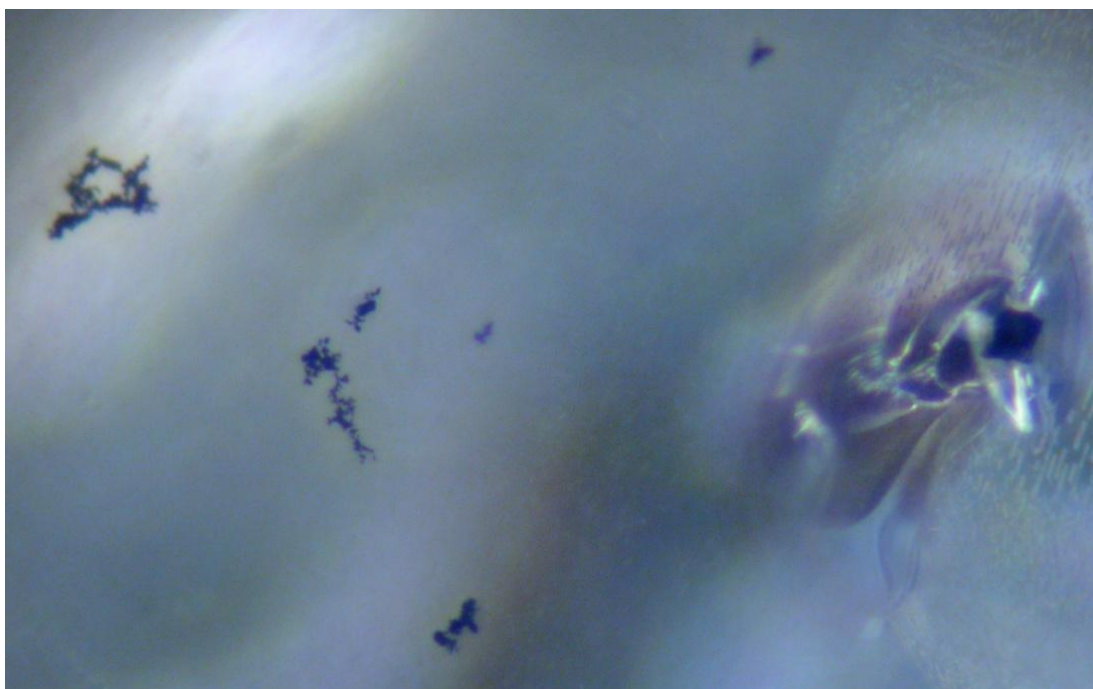


Figure 93: Small opaque black crystals in clusters with a larger uraninite-like crystal associated with unhealed tension fissures. Darkfield and fiber optic illumination, magnified 30x.

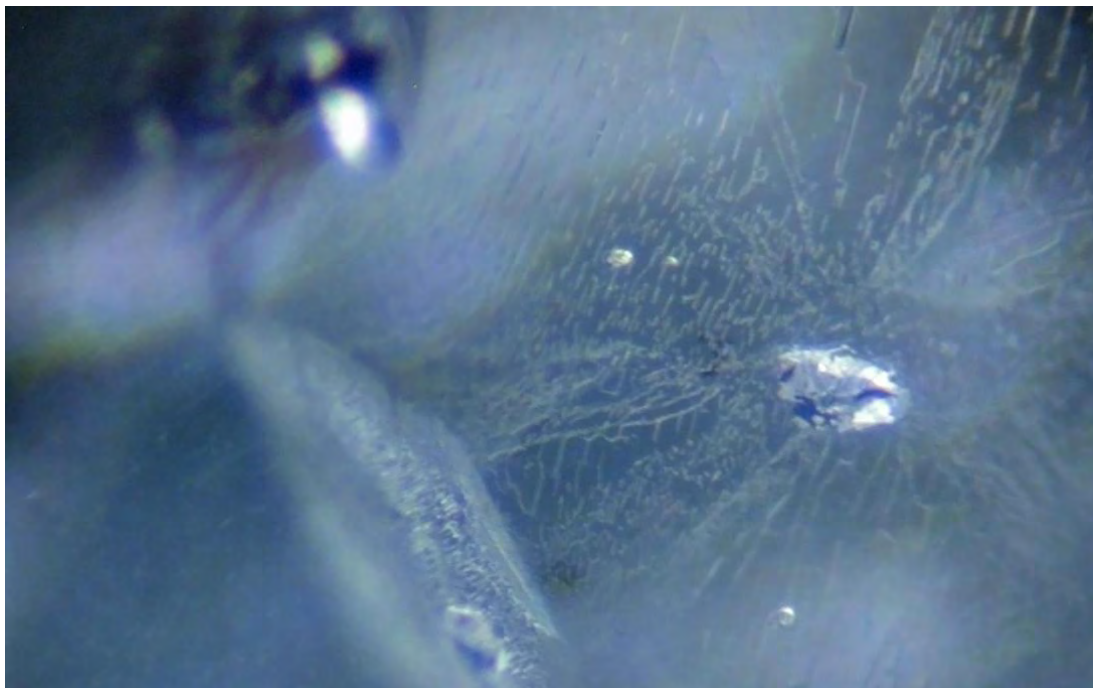


Figure 94: Negative crystals and healed fissures. Darkfield illumination, magnified 50x.

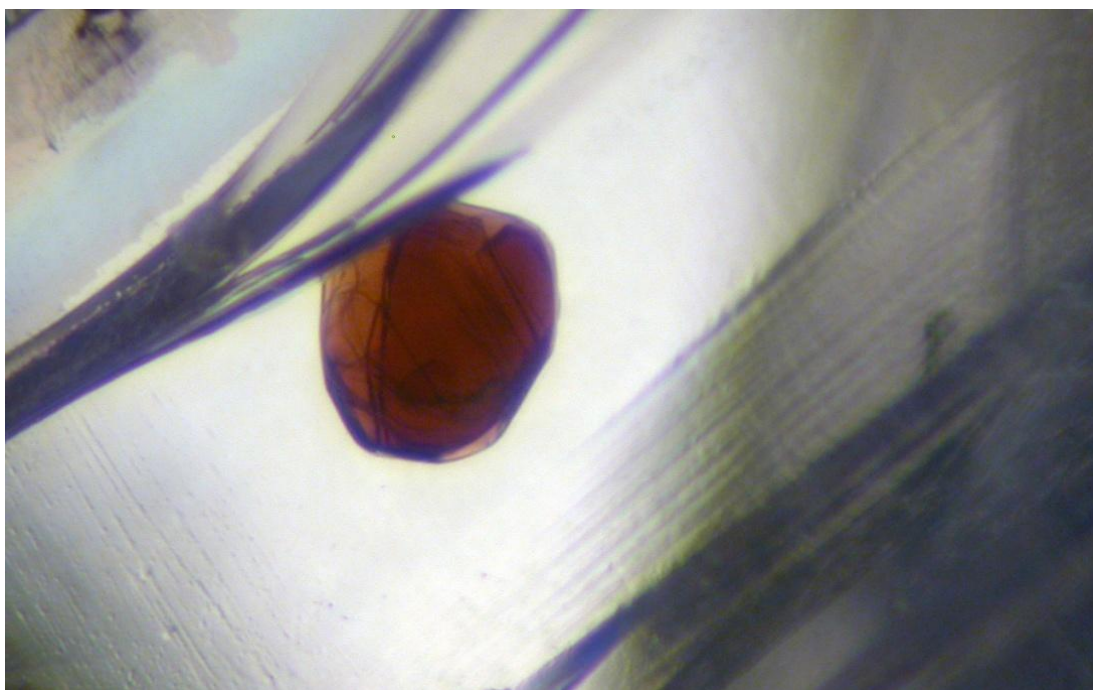


Figure 95: Mica-like crystal that is virtually morphologically identical to crystals that were identified as biotite using Raman spectroscopy. Brightfield illumination, magnified 50x.

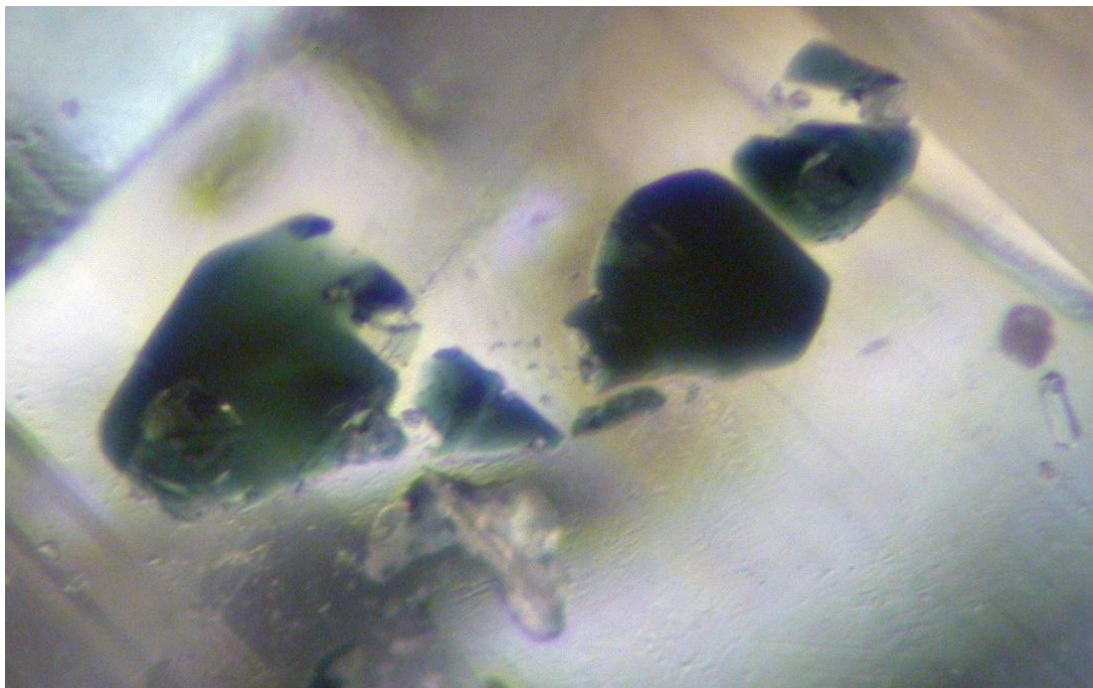


Figure 96: Green crystals resembling inclusions that were identified as spinel using Raman spectroscopy. Brightfield illumination, magnified 50x.

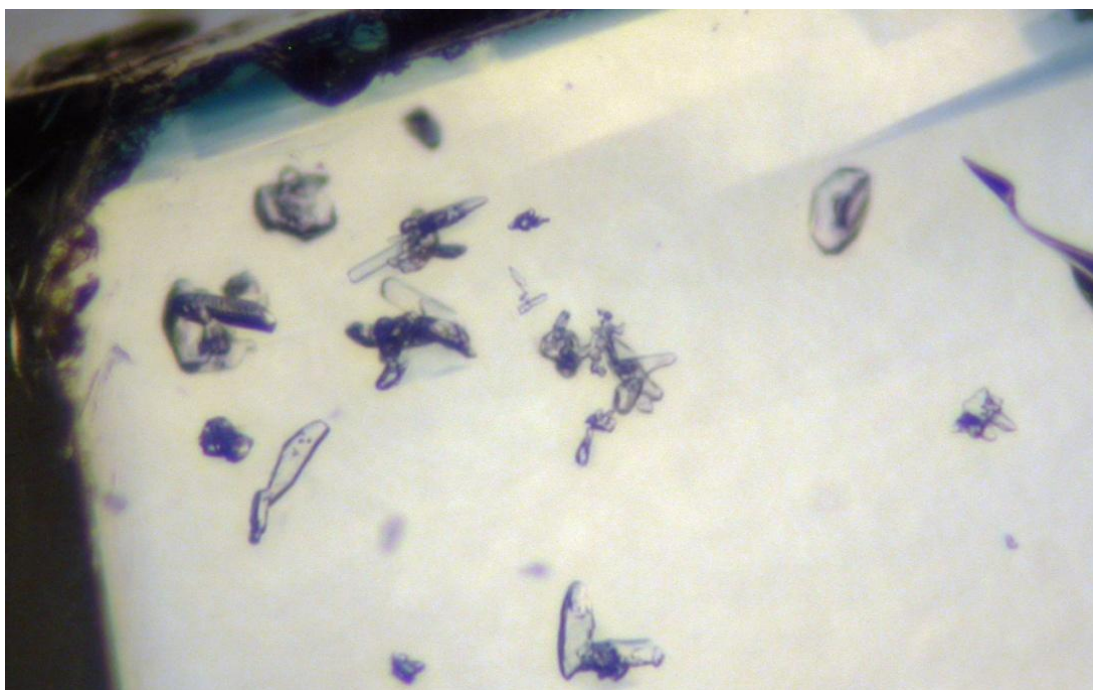


Figure 97: Colorless zircon-like crystals and blue surface-related color zoning. Brightfield illumination, magnified 50x.



Figure 98: Blue surface-related color zoning. Brightfield illumination, magnified 20x.

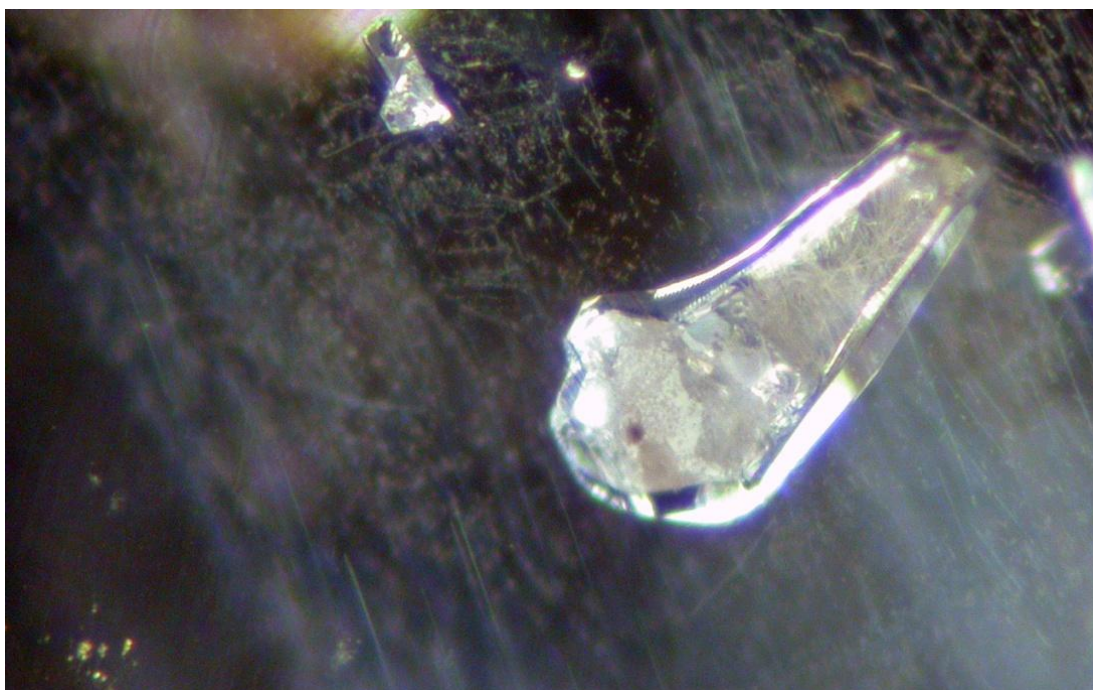


Figure 99: Negative crystals, minute particles, and needles. Darkfield and fiber optic illumination, magnified 50x.

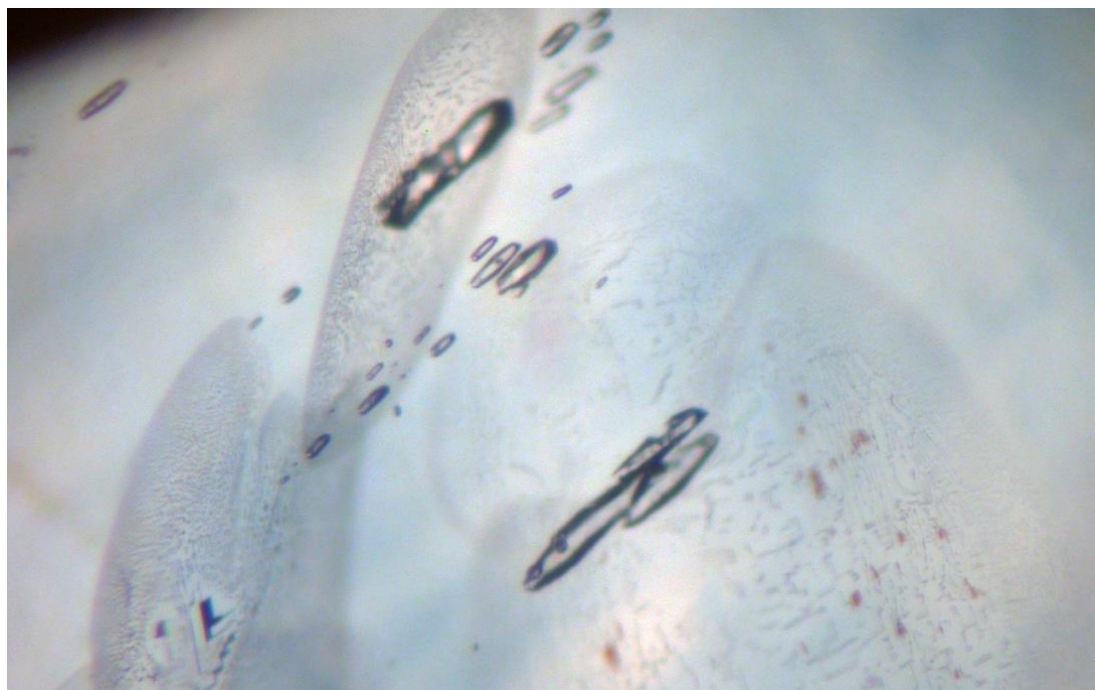


Figure 100: Colorless elongated zircon-like crystals and healed fissures. Brightfield illumination, magnified 50x.

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**ANNEX A: CONTENT FROM THE NATIONAL GEM & JEWELLERY
AUTHORITY WEBSITE PUBLISHED ON MARCH 1, 2012**

<http://www.srilankagemautho.com/st-currentevent.php>

**ANNEX B: INTERVIEW IN THE SUNDAY LEADER; PUBLISHED MARCH 4,
2012**

<http://www.thesundayleader.lk/2012/03/04/sri-lankas-multi-billion-rupee-gem-haul/>

ANNEX C: GIA FIELD GEMOLOGY CATALOGUING SYSTEM

Cataloguing classifications:

A Conditions: The stone was mined by the field gemologist.

B Conditions: The field gemologist collected the stones at the mines after witnessing the mining.

C Conditions: The field gemologist collected the stones from the miners at the mine, but without witnessing the mining.

D Conditions: The field gemologist collected the stones from the miners, but not at the mine.

E Conditions: The field gemologist collected the stones from a secondary source close to the mines.

F Conditions: The field gemologist collected the stones from a secondary source in the international market.

Z Conditions: The field gemologist was not able to obtain any information about the conditions under which the stone was collected.

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