

Sapphires Reportedly from Batakundi/Basil area

A preliminary examination and a comparison with rubies and pink sapphires from other deposits in Central Asia.

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Figure 1: Several rough and faceted purplish pink sapphires reported to have been mined from the Batakundi-Basil area located in a border area between Pakistan's controlled Kashmir (Azad Kashmir) and Pakistan's Northern Areas province. This remote deposit is located not very far from the Nangimali ruby mining area located in Pakistan controlled Kashmir close to the "1972 cease fire line" separating the Indian and Pakistan controlled Kashmir. Photo: V. Pardieu

Introduction:

Recently several unusual purple sapphires (Figure 1) were submitted to the GIA Laboratory Bangkok for examination by Mr Zulfiqar Ali Abbas from “Kashmir Gems” (pvt), Ltd (Pakistan). The stones were reported to have been mined in Kashmir near the villages of Batakundi and Basil located in Pakistan controlled Kashmir (Figure 1 and Figure 2).

This study focuses on the gemological description of the “Batakundi” stones seen in April 2009 (Figure 1) and their comparison with rubies and pink/purple sapphires from known deposits in Central Asia. The study also relates some of the challenges presented when attempting the origin determination of gemstones, particularly at a time when rubies and sapphires are mined from many new, remote and relatively unknown deposits.

“Kashmir, a complicated story but priceless brand name”: The Kashmir region (Figure 2) hosts one of the world’s most famous sapphire deposits located near Sumjam village in “Jammu and Kashmir”; a province controlled by India. This deposit, discovered at the end of the 19th century, produced sapphires that became famous for their much loved color and “sleepy” appearance. However, the remoteness and romance of the location as related by the advancing army of rich British tourists to this “*Princely State of Kashmir and Jammu*” when India was regarded as “*the Jewel in the Crown*” of the British Empire, added to the stone’s lore.

Today the origin “Kashmir”, as associated with blue sapphires, is a strong selling tool: “Kashmir sapphires” are viewed as being extremely rare gems that evoke the romance and the glory of a lost empire to the extent that their market value is higher when compared with stones of a similar appearance but coming from other origins. As market value can be very different for stones of similar a similar appearance but from different origins, gemological laboratories are commonly asked to state their opinion on a stone’s country of origin; this being of particular importance for stones with a potential “Kashmir origin”.

In 2006 one of the authors (VP) visited the Namak Mandi gem market in Peshawar where the stones reported from Batakundi or Nangimali areas located in Pakistan controlled Kashmir are commonly described as “Kashmir” rubies or sapphires based on their color. Nevertheless these stones are quite different from the famous “Kashmir” sapphires mined in the Indian controlled “Jammu and Kashmir” region.

Originally the description “Kashmir” was used only to refer to the Kashmir Valley, an area located in the current Jammu and Kashmir province. However, as the Maharaja of Kashmir extended his rule over many other regions outside of the Kashmir Valley, the entire region under the rule of the Prince of Kashmir became known as “Kashmir”. Subsequently the borders of the region were further confused by the Pakistan - India

and China territorial conflict (Figure 2). Thus “Kashmir” refers to a disputed region composed of many different valleys, including the Kashmir Valley and these uncertain political borders complicate the place-naming of rubies and sapphires from area.

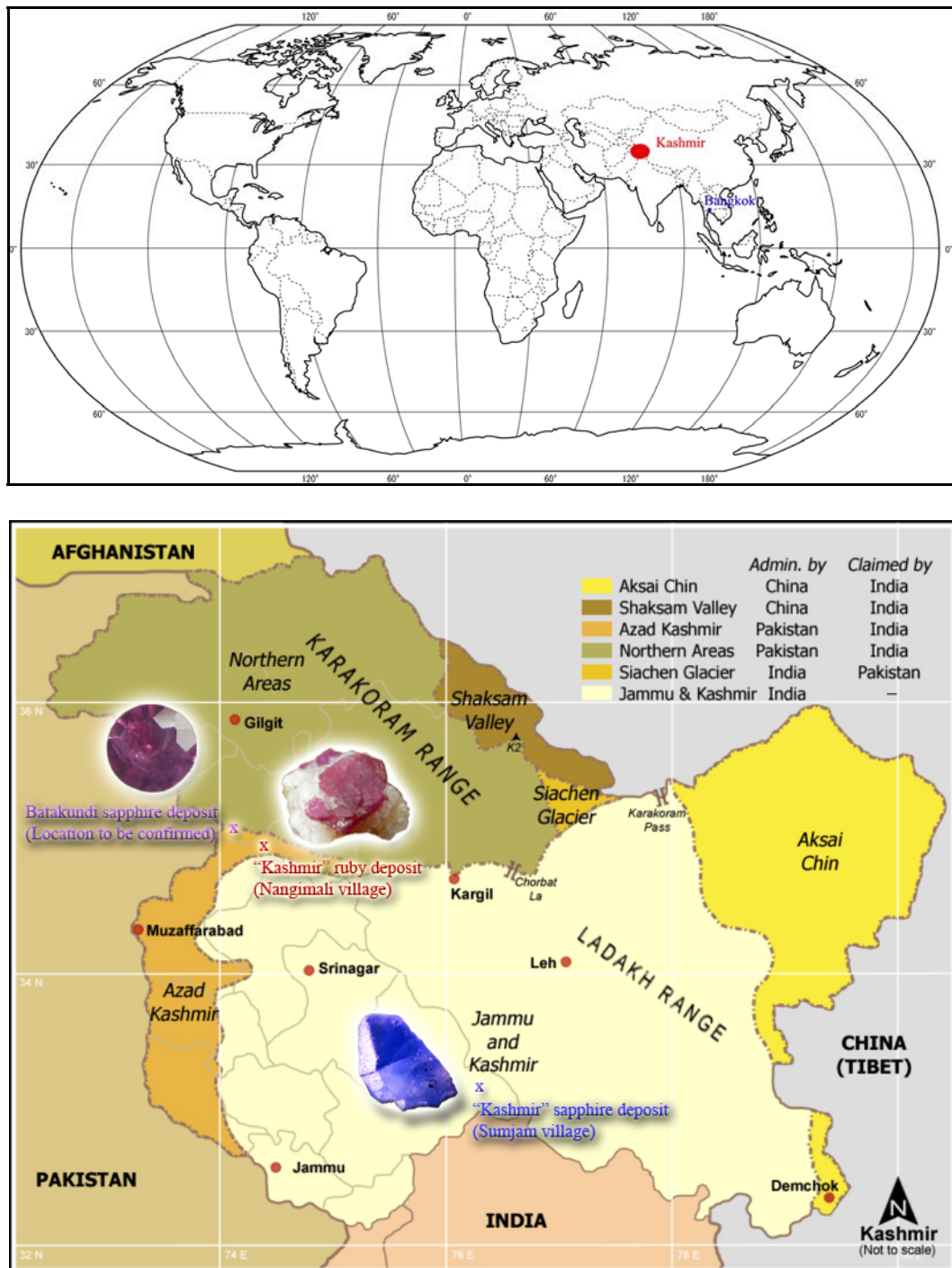


Figure 2: Map of the former Kashmir Province showing the complexity of the local situation regarding Country of Origin Determination and the location of its ruby and sapphire deposits. The former Kashmir province is currently administrated by India, China and Pakistan but the borders are the subject of a territorial dispute between them since the partition of India and Pakistan in 1947.

Sapphires reportedly from the Batakundi / Basil area in Pakistan Controlled Kashmir:

Batakundi was briefly described as a corundum locality by Garnier (Garnier, 2003) and again by Quinn (Quinn, 2004). In mid June 2006, one of the authors (V.P.) was visiting the Namak Mandi gem market¹ in Peshawar Pakistan to prepare for various expeditions to ruby, emerald and spinel mines in the region. While there he examined several parcels of rubies, purple and blue sapphires from the different mining areas in Central Asia; The main material in the market at that time were stated to be from Jagdalek in Afghanistan (Bowersox, 2000, Pardieu, 2006) a mining area known for several centuries and Murgab in Tajikistan (Smith, 1998, Hughes, 2006, Pardieu, 2006, Pardieu, 2007) which after a short activity in the 1990's started to produce again at the end of 2005.

VP was surprised that no stones from the Hunza² ruby and spinel deposit seemed to be available (Okrusch, *et al.*, 1976, Gübelin, 1982, Piat, 1974). However, he did observe a few parcels of dark red, purplish or bright red rubies - all described as coming from Kashmir. Local traders stated that the bright red stones were from Kel – Nangimali, (Kane, 1997, Pecher, *et al.*, 2002, Garnier, *et al.*, 2004, Pardieu, 2006) a remote mining area discovered in 1979 and located, on the Pakistan side, a few kilometers from the 1972 cease fire line separating Pakistan and India controlled Kashmir. The dark red, purple, pink and blue stones were stated to be associated with the Batakundi deposit (Clutterbuck, 2009). It appeared that there are in fact 2 deposits; The Batakundi ruby deposit producing dark red rubies and the Batakundi Basil producing purplish pink stones. As VP was planning to visit the Batakundi and the Nangimali areas in the following weeks, it was decided not to buy these (expensive) samples but as several stones displayed a strong and very unusual red color zoning he decided to photographically record some of them (Figure 3).



Figure 3: Three purple sapphires as seen in Peshawar gem market in June 2006, the stones on the left got the author attention due to its unusual strong hexagonal red color banding. Photos: V. Pardieu/AIGS-ICA-Gubelin, June 2006

¹ The Namak Mandi gem market is Central Asia's main gemstone trading centre.

² The Hunza deposit is in the north of Pakistan and was discovered in 1970's during the road works for the Karakoram highway

In August 2006 VP's expedition to the ruby and sapphire mines in Nangimali and Batakundi turned out to be very difficult, firstly as the area was still recovering from the terrible earthquake which affected Kashmir in Oct 2005 (numerous landslides were blocking the roads in the Neelam valley between Muzafarabad and Kel). This resulted in the loss of several days on the way to the Nangimali mines and time was then too short to visit the remote Batakundi area. Secondly, the collection of samples from these areas turned out to be very difficult as the Nangimali mine was run by the Pakistan Government who had strict rules concerning the way the gemstone production was sold. Therefore, while VP was able, with the support of the Geologic Survey of Pakistan, to visit the mines to study and document the rubies in the host rock as well as the mine production at Nangimali, he was not allowed to collect any ruby samples at the mines. Nevertheless he was able to obtain a few bright red Nangimali rubies and few dark red Batakundi rubies from local traders, but he was not able (after returning to the Namak Mandi gem market from Kashmir) to acquire any purple-pink-blue samples from Batakundi.

To VP's knowledge the only foreigner to have visited the Batakundi deposit so far is the British gem dealer Guy Clutterbuck who confirmed that the area was producing some dark red rubies of fine quality but mostly less than 1 carat in size and also some pink-purple-blue sapphires. (Clutterbuck, 2009)

In summer of 2008, V.P., while still trying to obtain samples from the Batakundi/Basil areas, was informed that "Kashmir sapphires" from this area (Figure 4) had become more available in Peshawar. Nevertheless, this time again, arrangements could not be made to acquire any study specimens as the owners were not willing to cut one or two stones from their large parcel.



Figure 4: Sapphires reported from Batakundi as seen in Peshawar, Pakistan during summer 2008.

In April 2009, after studying the stones submitted to the GIA Laboratory Bangkok (Figure 1), Ken Scarratt found them to be similar to three samples in his reference collection that were obtained in Bangkok market in 2007 with a reported origin of "Pakistan" (Figure 5).



Figure 5: Three purple sapphires from Ken Scarratt reference collection reported as from “Pakistan”, Photo: V.Pardieu

The three stones (Figure 5) were then added to this study for comparison as well as many rubies and pink sapphires from other known deposits in Central Asia.

Gemological description of the Batakundi sapphire material

Gemological studies on 9 unheated faceted purple sapphires and several rough specimens (Figure 1) sent to the GIA Laboratory Bangkok by “Kashmir gems Co. Ltd.” were performed by the authors. The unheated nature of the stones was confirmed by microscopic examination and spectroscopy.

The material used for the study was from light pink to purplish pink and to pinkish purple. The stones were transparent to milky and some stones were displaying some strong red color banding. Generally speaking the visual appearance of these pink and purple sapphires was reminiscent of some Pink to purple sapphires from Antsirabe area (Ambohimandroso) in Madagascar or from Guinea.

Chemistry

The chemistry of the purple sapphires from the Batakundi area was analyzed using EDXRF (Energy Dispersive X-ray fluorescence). The instrument employed was the Quant’x by Thermo Electron, using fundamental parameters (Theoretical) and in-corundum elemental standards. Only Ti, V, Cr, Fe, and Ga were analyzed.

The quantitative data obtained provides some insight on their source type and helps regarding the origin determination of these sapphires. Their chemistry is characterized

by medium levels of iron, vanadium, gallium and titanium. Tables 1 to 11 set out the results for each of the samples.

Table 1: Stone number 1: Pinkish purple sapphire, 0.200cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.054	0.016	0.074	0.128	0.008
elemental ppmw	325	87	504	994	59
elemental ppma	138	35	197	363	17



Table 2 Stone number 2: Pinkish purple sapphire, 0.296cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.025	0.024	0.129	0.157	0.010
elemental ppmw	149	134	882	1219	72
elemental ppma	63	53	345	445	21

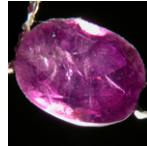


Table 3: Stone number 3: Pinkish purple sapphire, 0.382cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.044	0.011	0.026	0.099	0.007
elemental ppmw	261	59	174	772	49
elemental ppma	111	23	68	281	14



Table 4 Stone number 4: Light Pink sapphire, 0.465 cts

units	Ti	V	Cr	Fe	Ga
oxide wt %	0.063	0.014	0.041	0.121	0.008
elemental ppmw	375	76	283	937	57
elemental ppma	159	30	111	342	16

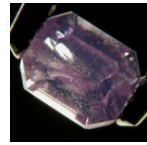


Table 5 Stone number 5: Pinkish purple sapphire, 0.303cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.052	0.032	0.037	0.098	0.009
elemental ppmw	309	180	252	759	67
elemental ppma	131	72	98	277	19



Table 6 Stone number 6: Pinkish purple sapphire, 0.508 cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.036	0.050	0.124	0.128	0.012
elemental ppmw	217	279	849	994	92
elemental ppma	92	111	333	363	27

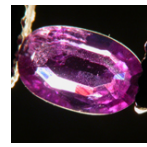


Table 7: Stone number 7: Milky Pinkish purple sapphire, 0.698 cts

units	Ti	V	Cr	Fe	Ga
oxide wt %	0.129	0.023	0.080	0.187	0.011
elemental ppmw	774	128	549	1454	84
elemental ppma	329	51	215	531	24



Table 8 Stone number 8: Pinkish purple sapphire, 0.863cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.063	0.024	0.052	0.164	0.011
elemental ppmw	379	131	355	1274	78.
elemental ppma	161	52	139	465	22



Table 9 Stone number 9: Pinkish purple sapphire, 2.31cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.061	0.032	0.120	0.214	0.013
elemental ppmw	365	181	820	1663	96
elemental ppma	155	72	321	607	28



Table 10: Rough Stone number 1: Pinkish purple sapphire, 5.273 cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.050	0.024	0.140	0.173	0.011
elemental ppmw	301	132	958	1343	83
elemental ppma	128	52	375	490	24



Table 11: Rough Stone number 2: Pinkish purple sapphire, 2.721cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.196	0.027	0.232	0.140	0.007
elemental ppmw	1174	155	1590	1095	55
elemental ppma	499	62	623	400	16



A limited comparison of the chemical data in Tables 1 to 11 with several ruby and sapphire reference stones from Pakistan and other deposits in Central Asia is shown in Figure 6. The comparison stones were; eighteen from Nangimali collected by Kane (1995) while visiting Kashmir, twenty nine faceted stones collected by Pardieu (2006) while visiting Pakistan (three dark red samples possibly from “Kashmir - Batakundi”, three bright red stones probably from Nangimali, eight pinkish red stones probably from Jagdalek (Afghanistan), and fifteen pinkish red stones probably from Murgab (Tajikistan)), three pink-purple sapphires from Pakistan acquired by Ken Scarratt (2007) in Bangkok from a reliable source (Figure 5), thirty pink to red stones from Tajikistan acquired by Ken Scarratt from reliable sources and one ruby reported from Hunza, Pakistan acquired by Ken Scarratt during the 1990’s in Tucson from a reliable source³.

It is interesting to see from the Ga/Fe population fields (Figure 6) that the chemistry of the material reportedly from Batakundi (Figure 1) is quite different from what is commonly found from rubies and pink sapphires from known deposits in Central Asia, except possibly for some stones from Jagdalek (Afghanistan). The other interesting thing is that these stones match perfectly with the three samples reportedly from Pakistan and from the reference collection of Ken Scarratt’s.

³ Regarding the use of the words “possibly”, “probably” and “reliable sources” see (Annex A, 0).

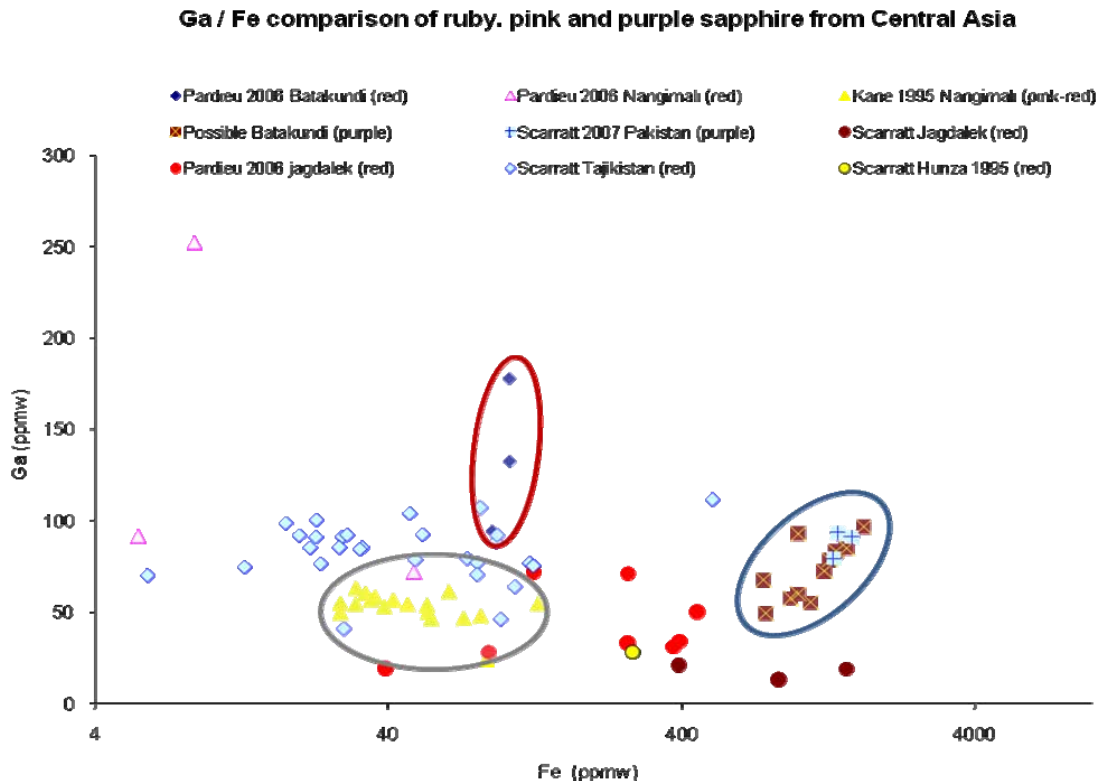


Figure 6: Comparison between rubies, pink and purple sapphires from Central Asian deposits based on chemistry using EDXRF

UV Fluorescence

The nine faceted sapphires and the rough specimens (Figure 1) were observed under both short wave and long wave ultra violet light using a UVP, UVLS-28 EL series, 8 watt, UV lamp with both 365 and 254nm radiation. Their reaction (Table 12) was found to be intermediate compared to the strong reaction commonly found in iron poor rubies like those from Nangimali but stronger than what is found in iron rich rubies from Thailand/Cambodia or some African ruby deposits like Winza ion Tanzania.

Table 12:

SWUV (253nm)	weak red to orangy-red
LWUV (365nm)	moderate to strong red to orangy-red

UV-Vis-NIR Spectrometry

The UV/visible spectra were collected on all the nine faceted and two rough samples using a Perkin Elmer Lambda 950 UV/Vis Spectrometer and its appropriate accessories. The spectra collected are dominated by Chromium and Iron absorptions with Cr^{3+} absorption bands around 405–410 and 560 nm together with a contribution of Fe^{3+} bands at around 377/388 nm and 465/480 nm (Emmett, 2009). In addition, the spectra generally displayed a strong “background absorption” starting around 600 nm and increasing toward the UV edge (Figure 7).

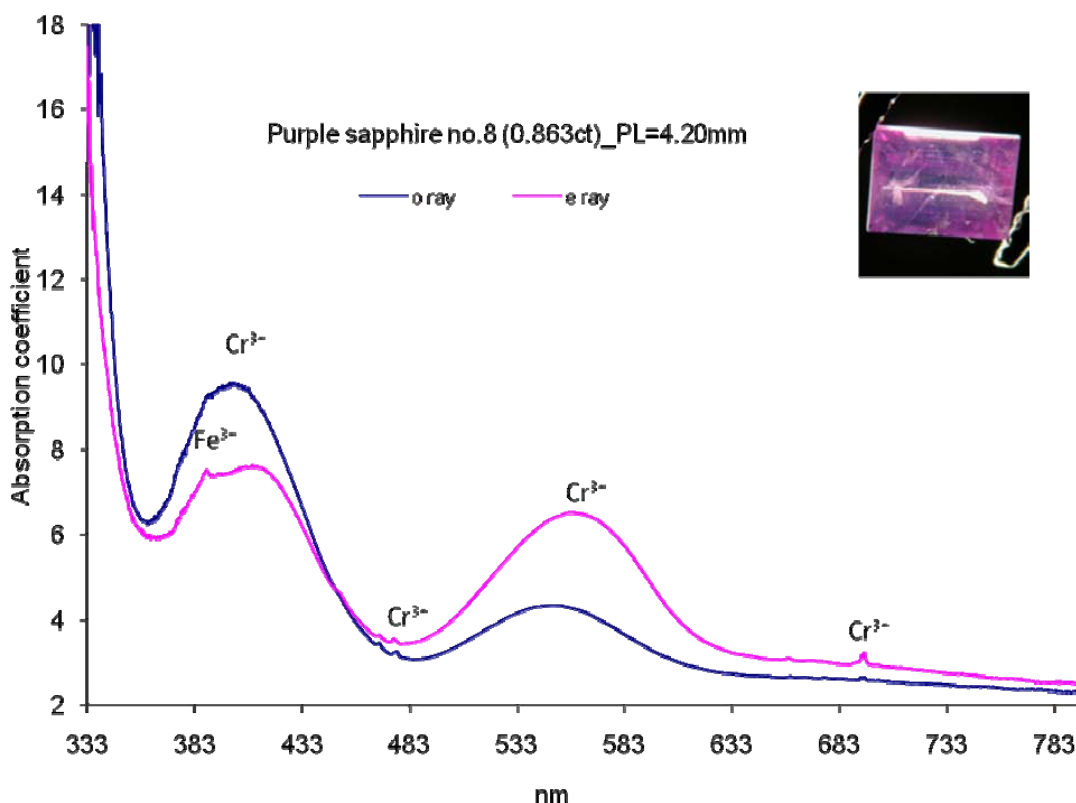


Figure 7: A typical UV-Vis spectrum of a purple sapphire reported from Batakundi.

Infrared spectroscopy

Infrared spectra were collected using a Thermo Nicolet 6700 FTIR⁴ and appropriate accessories. All the eleven stones (Figure 1) we studied and several interesting features were recorded.

All the samples studied recorded a broad band around 3200-3600^{cm-1} commonly associated with the presence of molecular water. Peaks were also recorded at 3084, 3317^{cm-1} and attributed to boehmite (Figure 8). Three out of nine sapphires we studied presented very distinct boehmite spectra and one stone also recorded peaks between 2527 - 2600^{cm-1} and between 2855 - 2920^{cm-1} which may be attributed to the presence of calcite.

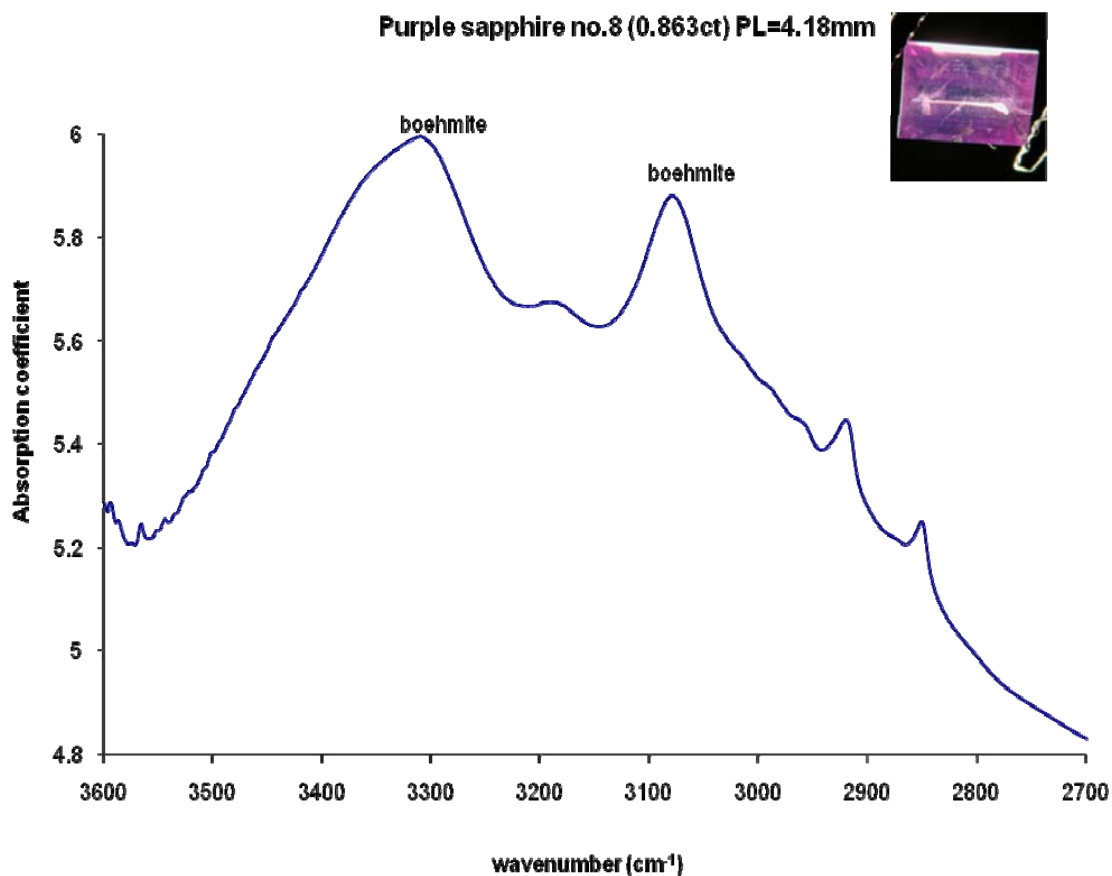


Figure 8: FTIR spectrum of a purple sapphire probably from Batakundi with clear Boehmite (associated probably with twinning)

The presence of boehmite, calcite and water related IR spectra are good indicators that the stones have not been heated. Calcite is likely related to crystal inclusions while boehmite is usually associated with twinning. These are common features in rubies and

⁴ FTIR: Fourier Transformed Infra-red spectrometry

sapphires from many different deposits around the world including those from Central Asia.

Examination of the purple sapphires probably from “Batakundi / Basil” area and comparison with rubies from other deposits in central Asia

Three crystal samples reported from the Batakundi area were studied at the GIA Laboratory Bangkok. The crystals were elongated with bipyramidal habit. Two crystals had a natural aspect while the third one had been polished (the sapphire crystals tend to be covered with a thick greenish fuchsite layer (probably verdite) itself covered with a graphite crust (Figure 9 and Figure 10)

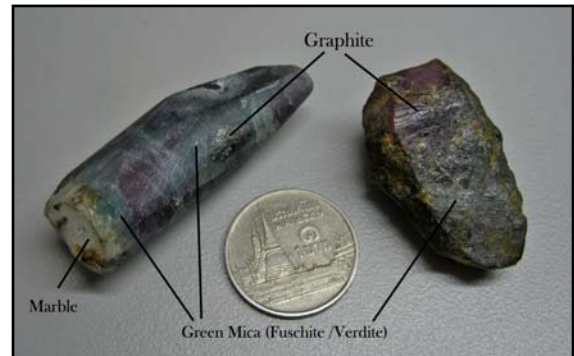


Figure 9: Sapphires reportedly from Batakundi, the specimen on the left was polished to remove most of the mica and the graphite covering it. Photo: V. Pardieu



Figure 10: Purple sapphire crystal, reportedly from Batakundi/Basil area, covered with a greenish rock (verdite probably) and a graphite crust. Photos: V. Pardieu

The aspect of these crystals (Figure 9 and Figure 10) differs from the appearance of crystals noted by VP while visiting ruby deposits in Central Asia during summer 2006. In Jagdalek (Afghanistan), Nangimali (Kashmir) and Murgab (Tajikistan) rubies were also commonly found with a bipyramidal habit, none were noted to have a graphite crust.

Rubies from Central Asia have a lot in common. They are found in marbles and were formed along faults and thrusts resulting from the Himalayan Orogeny when the Indian plate collided with the Asia. Fuchsite and graphite which are found associated with the sapphires reportedly from Batakundi are also commonly found in association with rubies from Nangimali, Jagdalek or Murgab deposits, but graphite usually occurs as tiny flakes in marbles near the ruby crystals, not as a thick crust covering them. Finally pyrite which is commonly associated with Nangimali rubies, and sometimes also with Jagdalek stones, was not thus far found associated with sapphires reportedly from Batakundi.

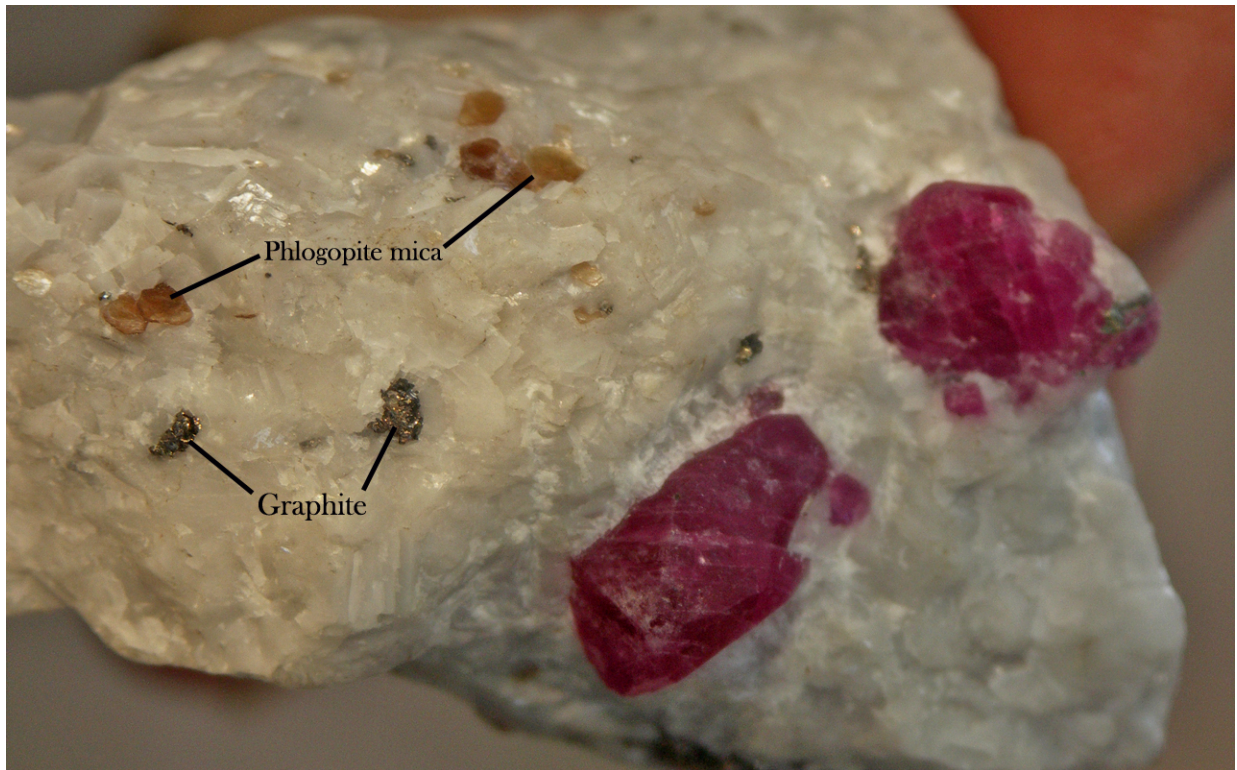


Figure 11: Rubies associated with marble, graphite and phlogopite mica as seen on site at the Jagdalek ruby mines. *Photo: V. Pardieu*

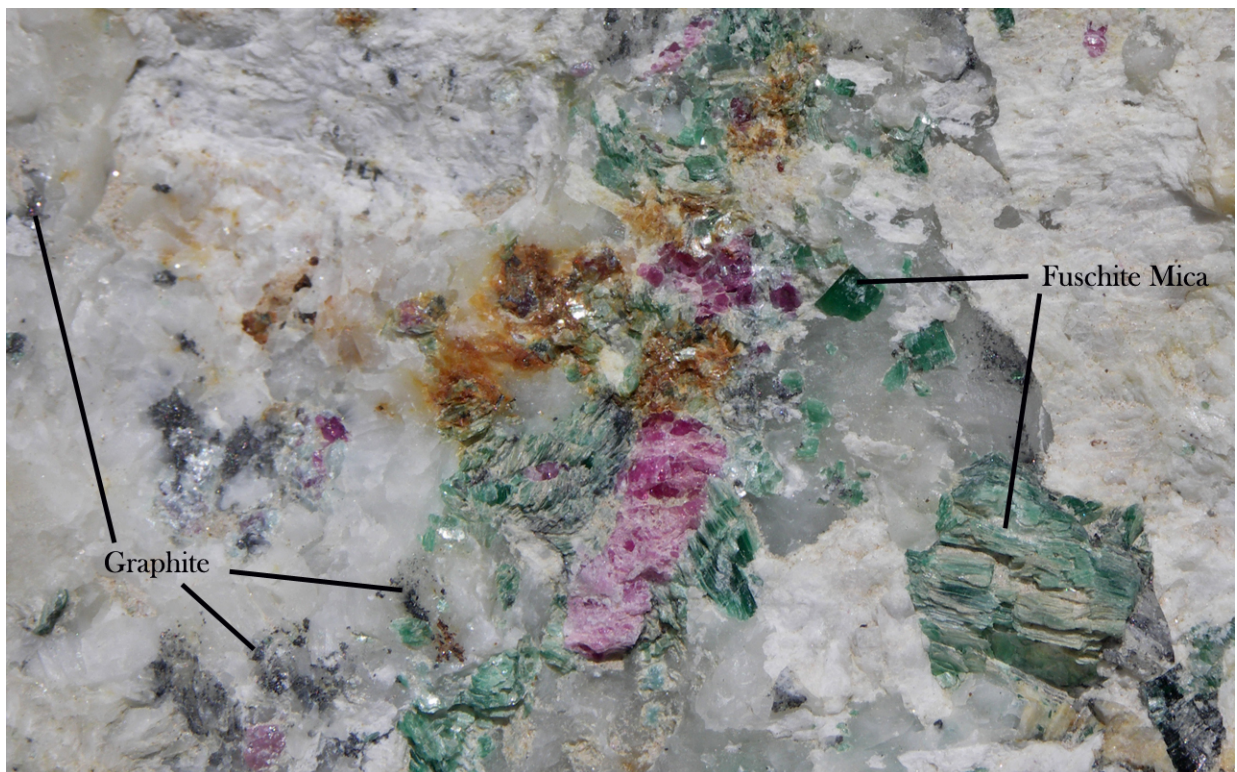


Figure 12: Rubies associated with marble, green mica and graphite seen on site at Snijnie mine near Murgab, Tajikistan. *Photo: V. Pardieu*



Figure 13: Ruby crystal associated with massive pyrite crystals seen at the Chittakatta ruby mines, Nangimali area, Pakistan controlled Kashmir. *Photo: V. Pardieu*

Microscopic examination of purple sapphire reportedly from Batakundi

Microscopic examination was performed using various GIA Gemolite microscopes at between 10 and 65x magnifications. The inclusion photos presented in this study were done using a Nikon Coolpix 4500 digital camera adapted on the GIA Gemolite microscope.

Apart from having similar chemistry, the purple sapphires reportedly from Batakundi (Figure 1) were found to be very similar in their inclusions to three stones from Pakistan seen in (Figure 5). The following pages, part 1 presents the inclusions recorded in the eleven stones submitted (Figure 1) and in (part 2) the 3 stones in (Figure 5). A first general observation is that these stones often present a strong red hexagonal color zoning (Figure 14, Figure 15, Figure 16, and Figure 18), which is quite an unusual inclusion scene in corundum. This inclusion scene was nevertheless very similar with the features seen and documented by VP in Peshawar in 2006 (Figure 3). In one case (Figure 17) some unusual wave like structures, similar to the “roiled effect” commonly seen in rubies from Mogok, (Burma) were seen perpendicular to the red growth lines.

Blue color zoning was not found while studying these 11 stones, although it was reported in other stones believed to have been mined from the same area (Figure 4). In the following photos the blue areas seen in Figure 14, Figure 16, Figure 24 and Figure 25 are in fact dark areas which became blue on the digital photos (an effect common to pink/purplish stones when using cross polars or dark field illumination and a digital Nikon Coolpix 4500). When photos are taken using the same camera under bright field conditions, the stones then display only red and colorless bands (Figure 15).

Tiny needles were found in several stones as low density clouds (Figure 19). Low density bands of minute particles were common giving the stone a turbid aspect (Figure 18). Using fiber optic illumination, several stones had a milky bluish purple appearance as it is sometimes the case with some rubies from Tajikistan (Figure 18 and Figure 19). Healed fissures were common in all stones studied including in association with negative crystals forming either planes (Figure 25) or stringers (Figure 26). Nevertheless except in one case surrounding a dark opaque crystal (Figure 21), these healed fissures associated with negative crystals were not presenting the equatorial “rosette” like structure common in blue sapphires from Sumjam (Kashmir) or in rubies from Tajikistan (Table 15).

The most common crystal inclusions found was massive black, opaque graphite (Figure 20). These graphite crystals are often related to colorless areas (Figure 30). Other mineral inclusions identified using Raman were isolated zircons (Figure 28) and calcite crystals. Twinning was also commonly found in several directions (Figure 16) and often in association with intersection tubes filled with boehmite (Figure 27).

(PART 1) An inclusion study of the 9 stones in Figure 1 reportedly from Batakundi



Figure 14: Hexagonal red colorless growth color zoning is a common and unusual feature seen in sapphires reportedly from Batakundi. Photo: V. Pardieu

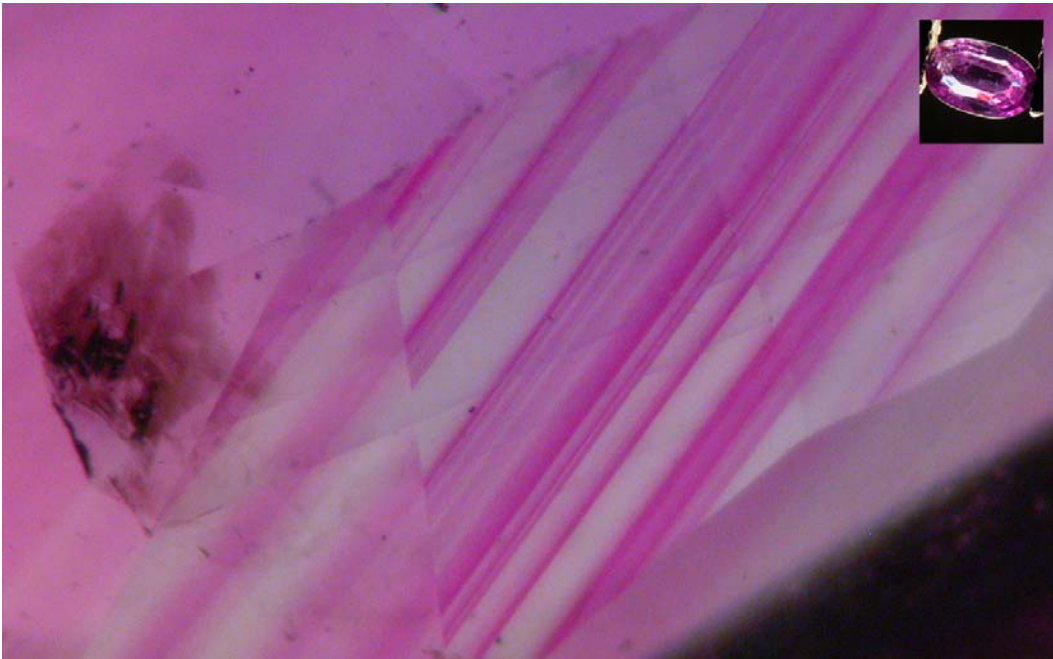


Figure 15: Red hexagonal color zoning associated with twinning planes under bright field, diffused lighting illumination. Photo: V. Pardieu

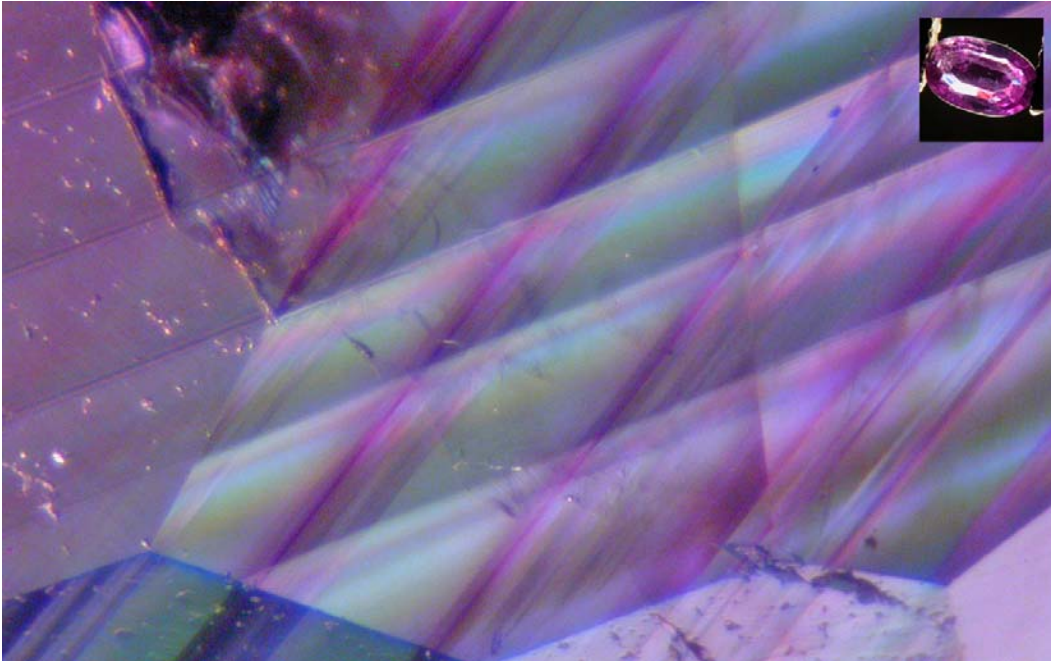


Figure 16: Red hexagonal color zoning associated with twinning planes as seen under cross polars illumination. *Photo: V. Pardieu*

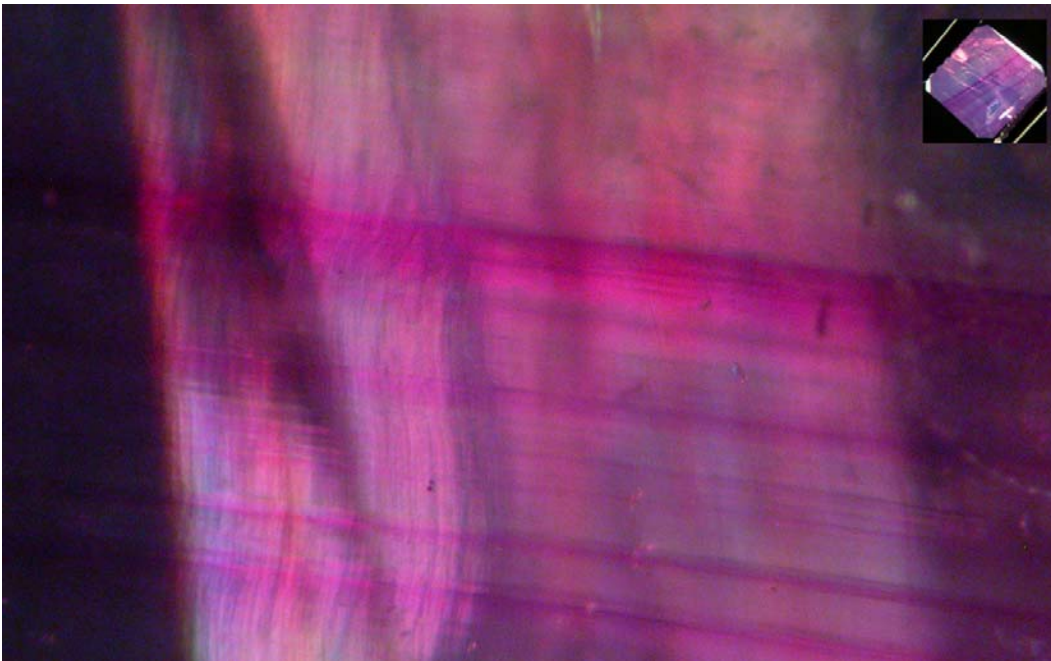


Figure 17: Besides hexagonal red color banding, syrupe growth lines reminding roiled structures of Mogok rubies can also be found perpendicular to the red growth lines. Dark field illumination. *Photo: V. Pardieu*

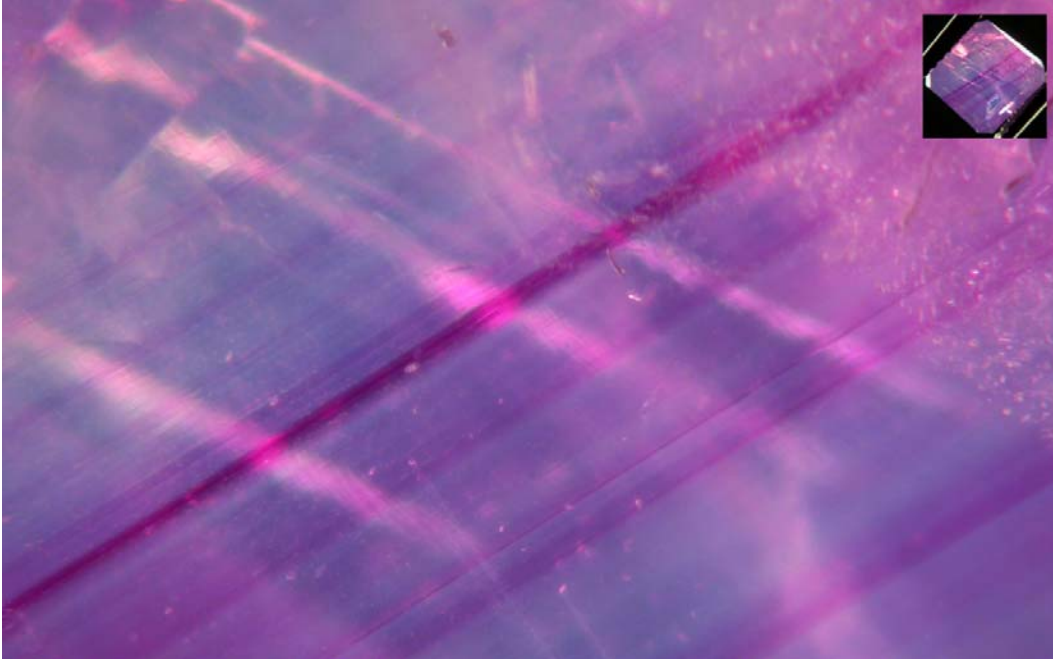


Figure 18: Red color zoning commonly alternate with colorless bands of minute particle giving the stone a milky turbid aspect. Fiber optics illumination. *Photo: V. Pardieu*

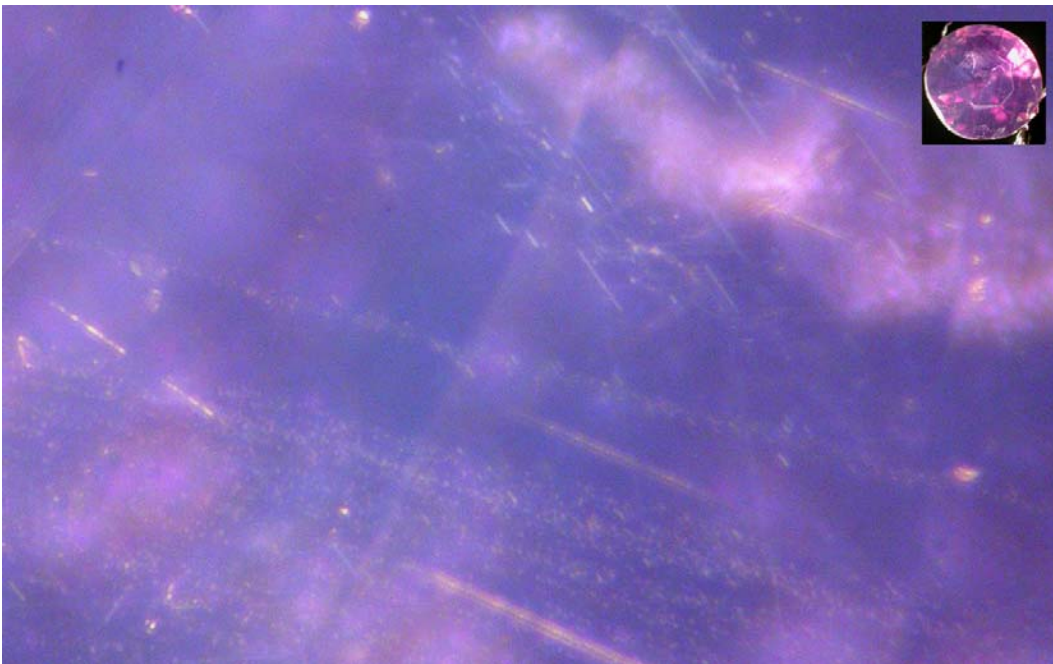


Figure 19: Minute particles in low density bands associated with tiny orientated needles are common features in sapphires reportedly from Batakundi. Fiber optics illumination. *Photo: V. Pardieu*

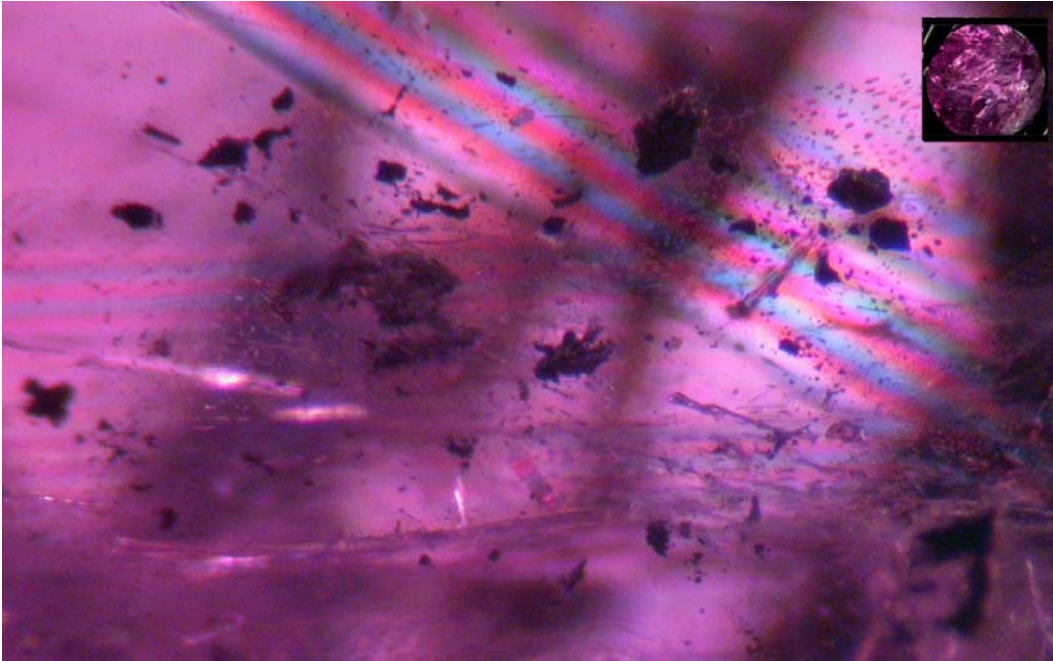


Figure 20: Graphite inclusions here associated with healed fissures and twinning are common in sapphires reportedly from Batakundi. Cross polars illumination. *Photo: V. Pardieu*

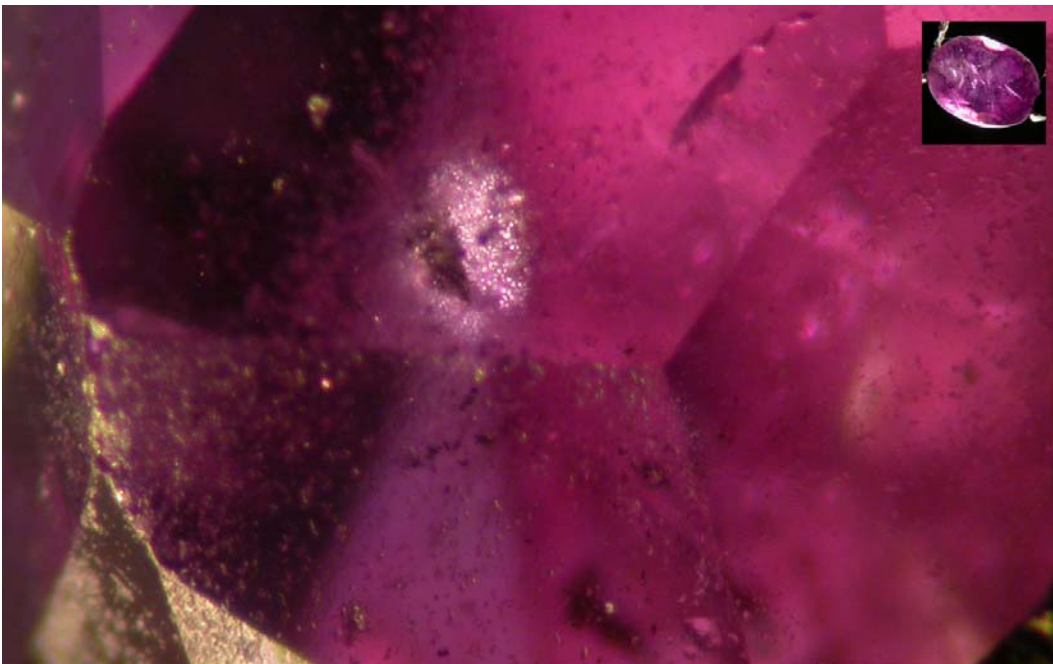


Figure 21: Dark opaque unknown crystal associated with equatorial reflective planar healed fissure. Dark field illumination. *Photo: V. Pardieu*

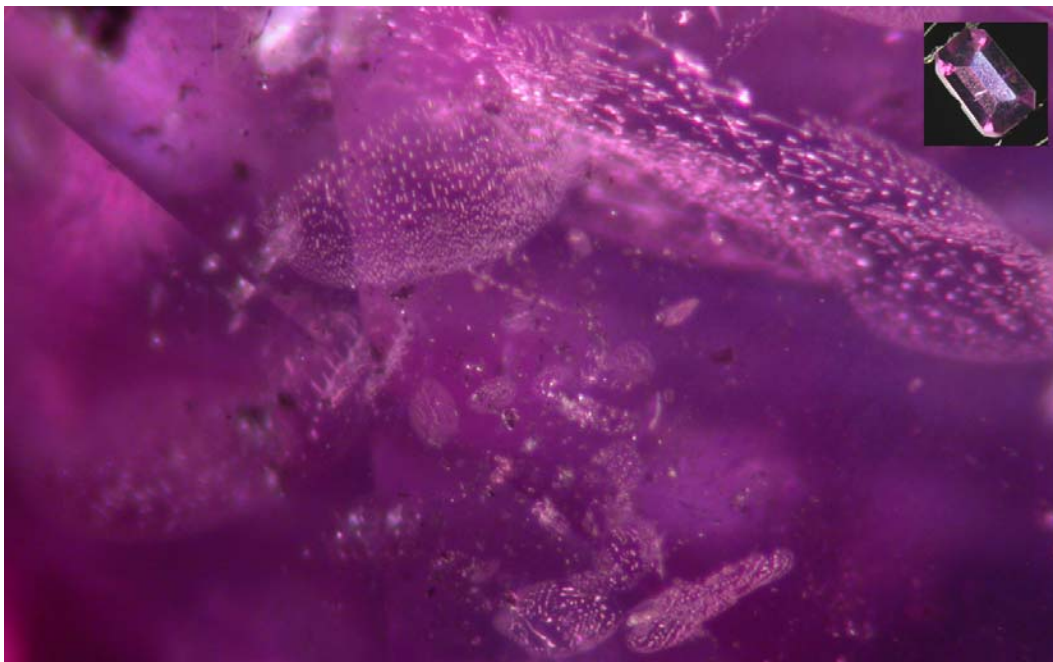


Figure 22: Healed fissures associated commonly with small black graphite inclusions. Dark field illumination. *Photo: V. Pardieu*

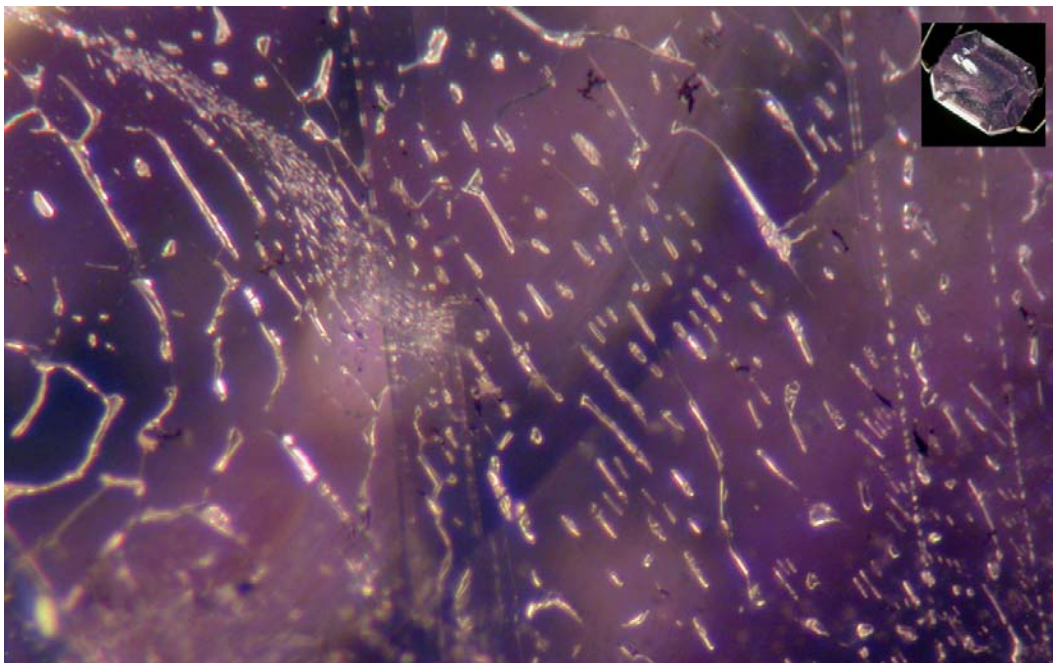


Figure 23: Details on a complicated healed fissure network associated with black opaque graphite inclusions. Dark field illumination. *Photo: V. Pardieu*



Figure 24: A crystal associated with healed fissures, red color zoning, minute particles forming low density milky bands. Fiber optics illumination. *Photo: V. Pardieu*

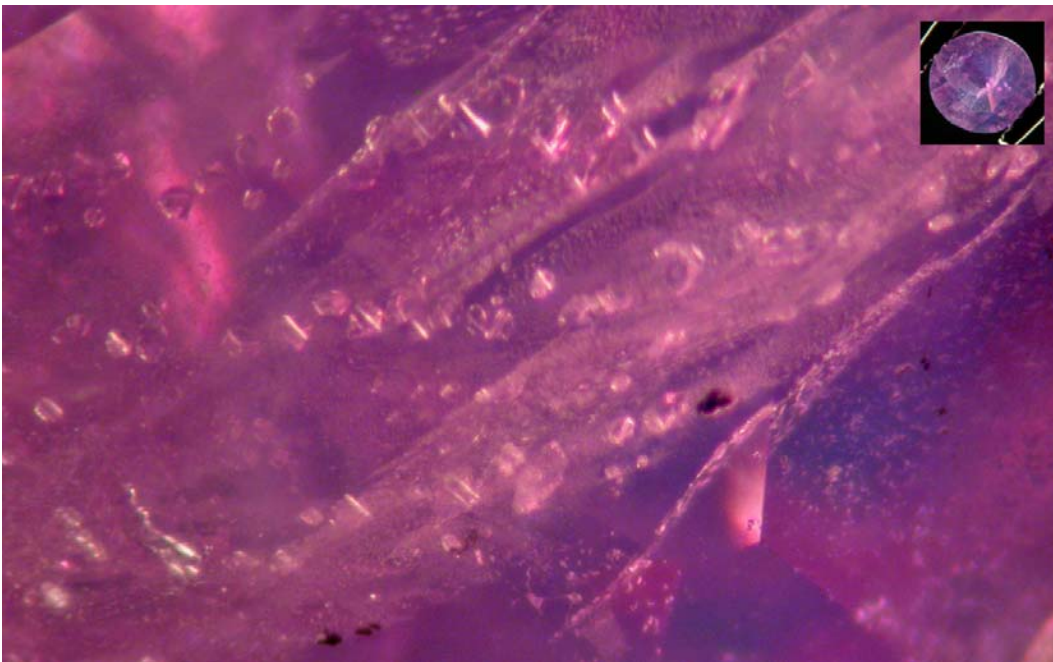


Figure 25: A plane of tabular negative crystals associated with healed fissures. Fiber optics illumination. *Photo: V. Pardieu*

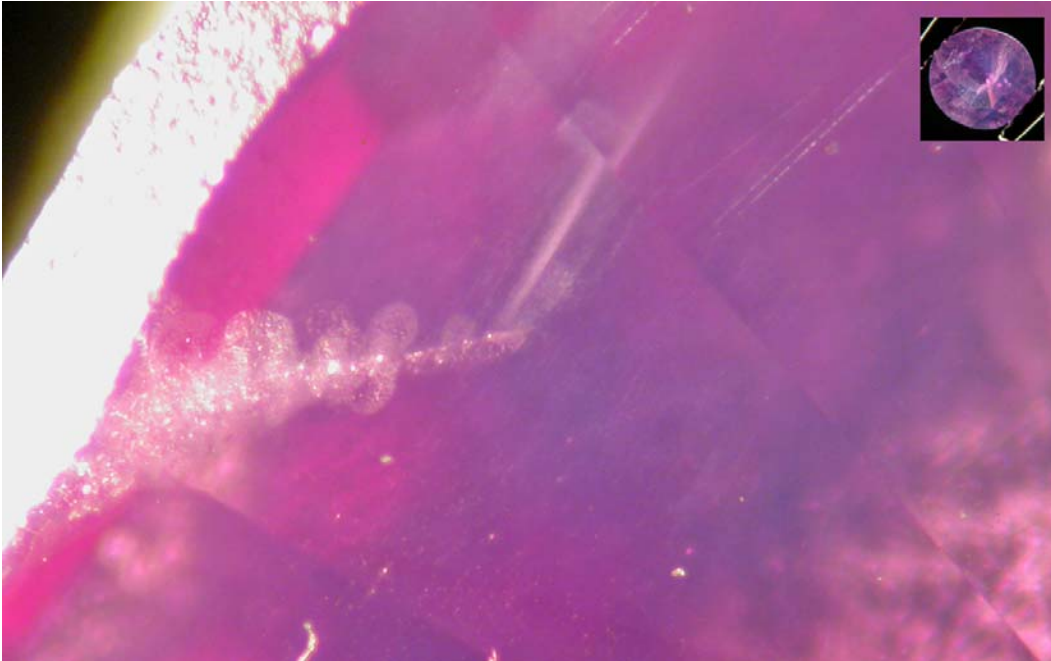


Figure 26: String of negative crystals associated with healed fissures. Fiber optics illumination. *Photo: V. Pardieu*

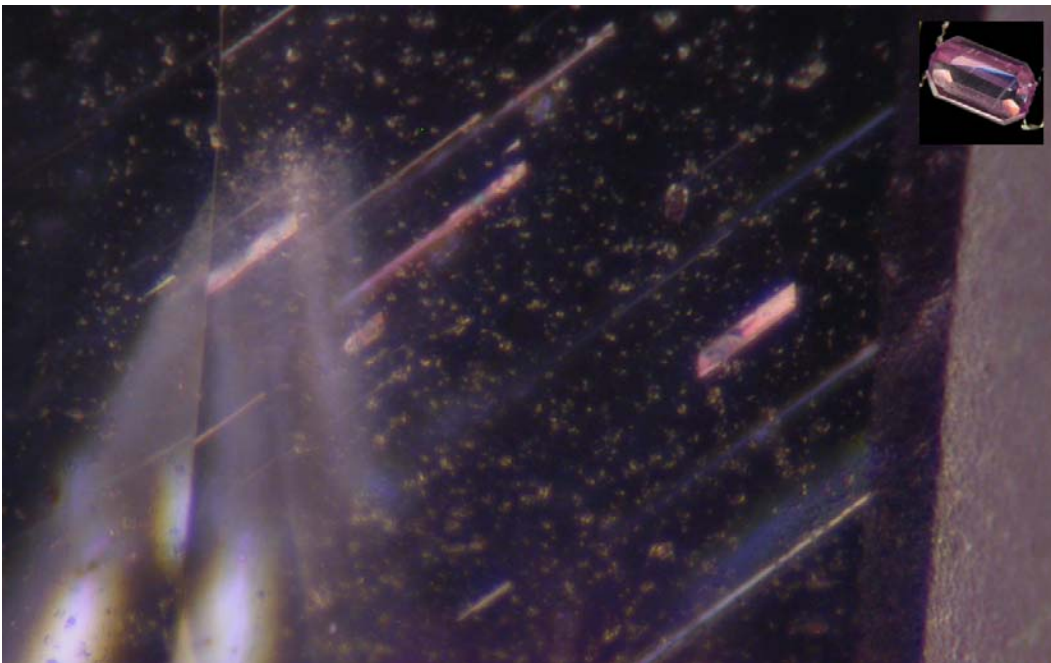


Figure 27: Orientated tube like inclusions associated with twinning planes and interestingly on the left part of the photo with a cloud of particles reminding the “comet tail” structures associated with some crystals. The crystal at the origin of the comet tail is not anymore present as the stone was faceted. But this cloud is very similar to what is visible in Figure 32. *Photo: V. Pardieu*

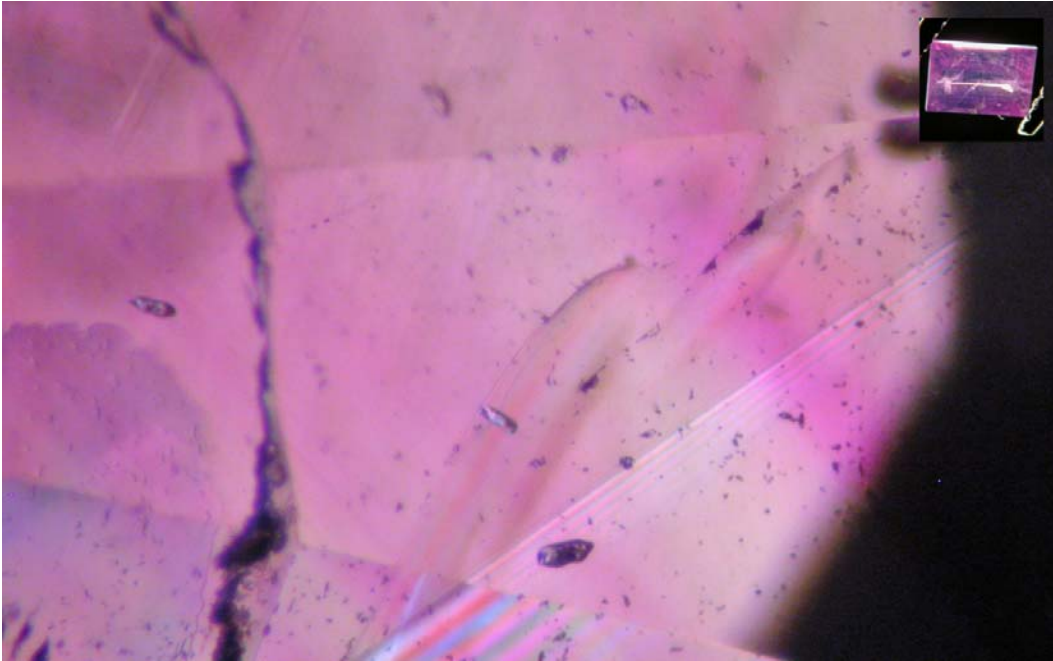


Figure 28: Isolated zircon crystals associated with twinning plane. Cross polars illumination. *Photo: V. Pardieu*

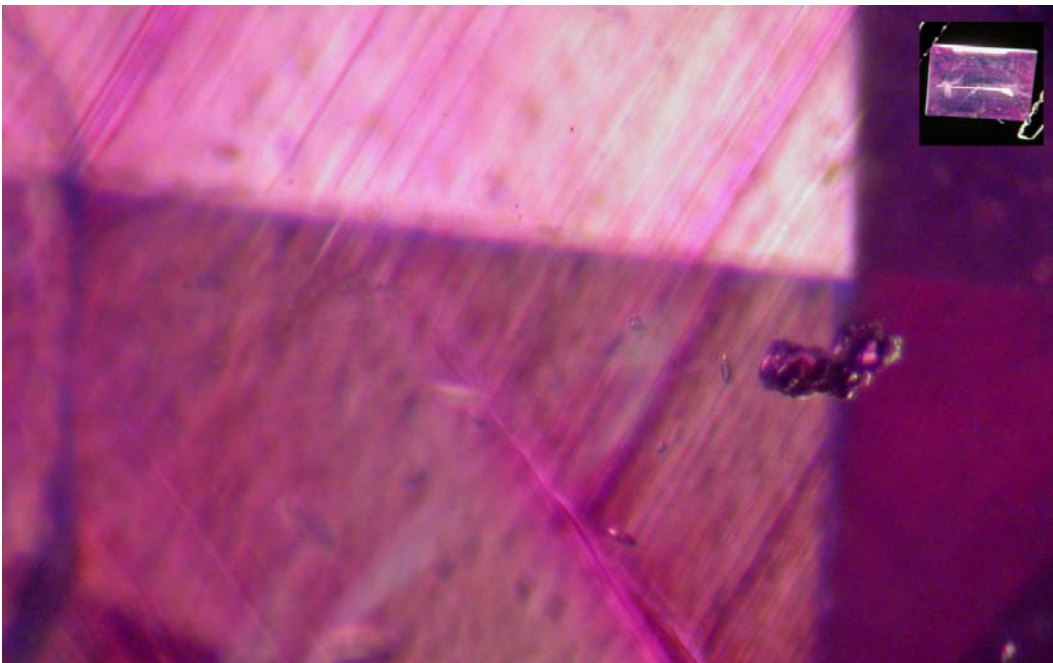


Figure 29: A colorful photo showing dark opaque graphite associated with zircon crystals and red hexagonal banding. Dark field illumination. *Photo: V. Pardieu*

(Part 2) Inclusion study of the three stones in Figure 5

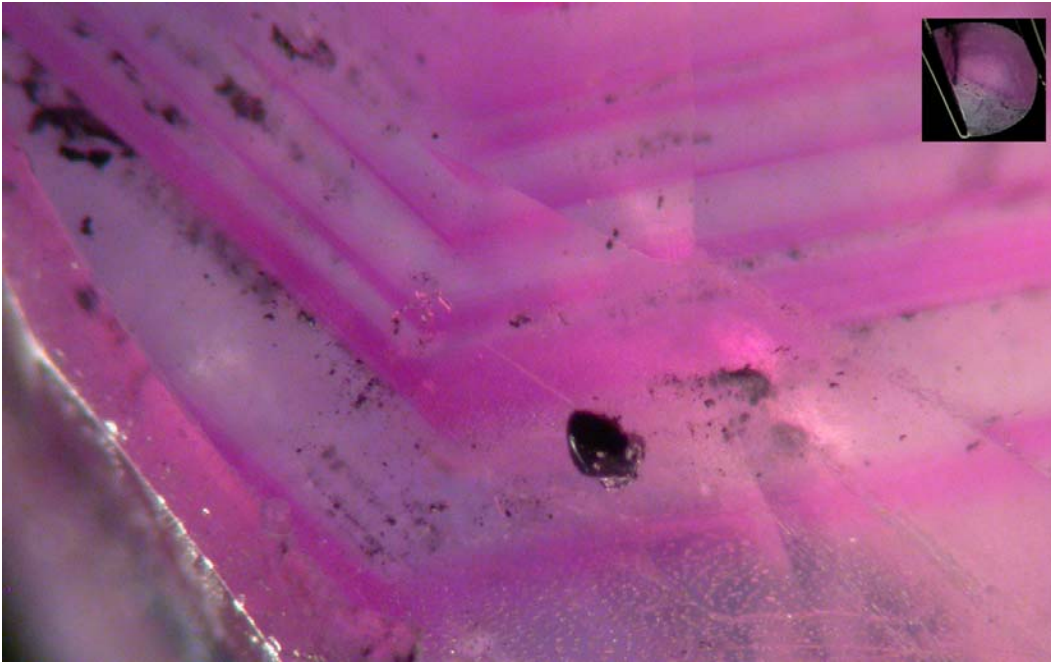


Figure 30: Strong hexagonal red zoning is well visible here as well as black opaque graphite inclusions associated with colorless turbid areas as seen in a stone reportedly from Pakistan from Ken Scarratt Reference collection. The similarities with the material submitted are clear. Fiber Optics illumination. *Photo: V. Pardieu*

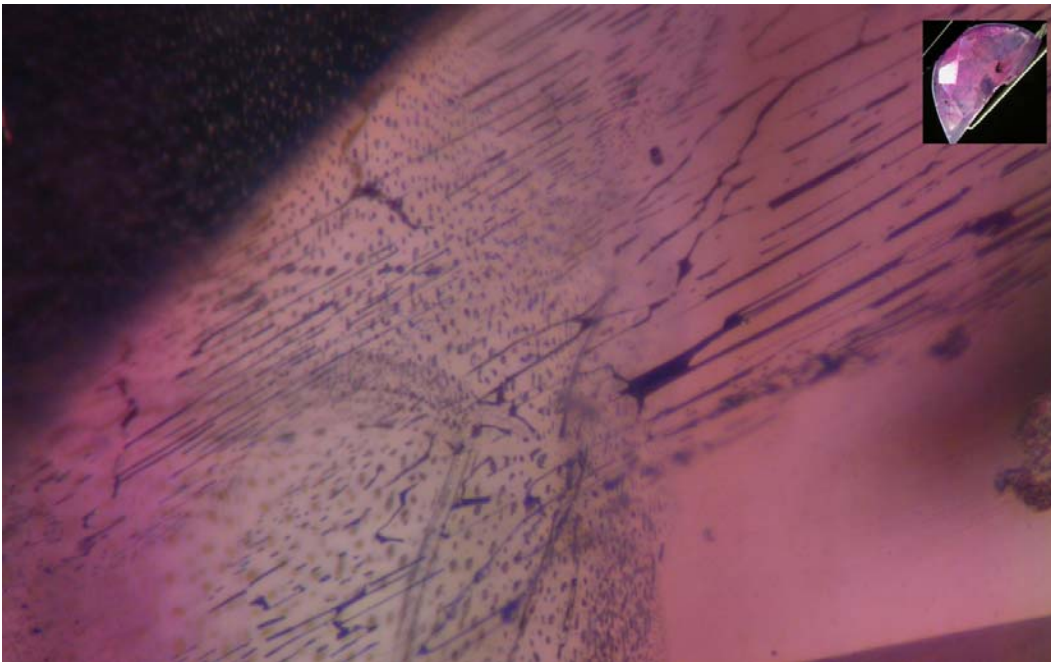


Figure 31: An artistic association of healed fissures and color zoning in a sapphire reportedly from Pakistan from Ken Scarratt collection. Bright diffused lighting illumination. *Photo: V. Pardieu*

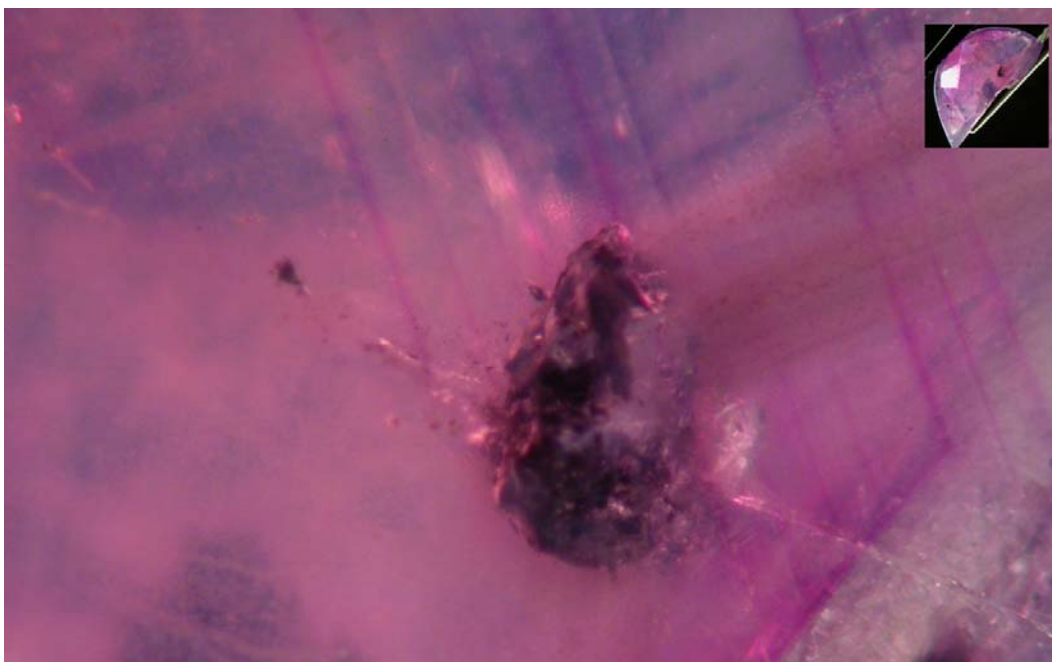


Figure 32: Dark opaque crystal associated with a comet tail like structure perpendicular to the growth lines and the red color bands as seen in one of the 3 stones from ken Scarratt reference collection. Fiber optics illumination. Photo: V. Pardieu

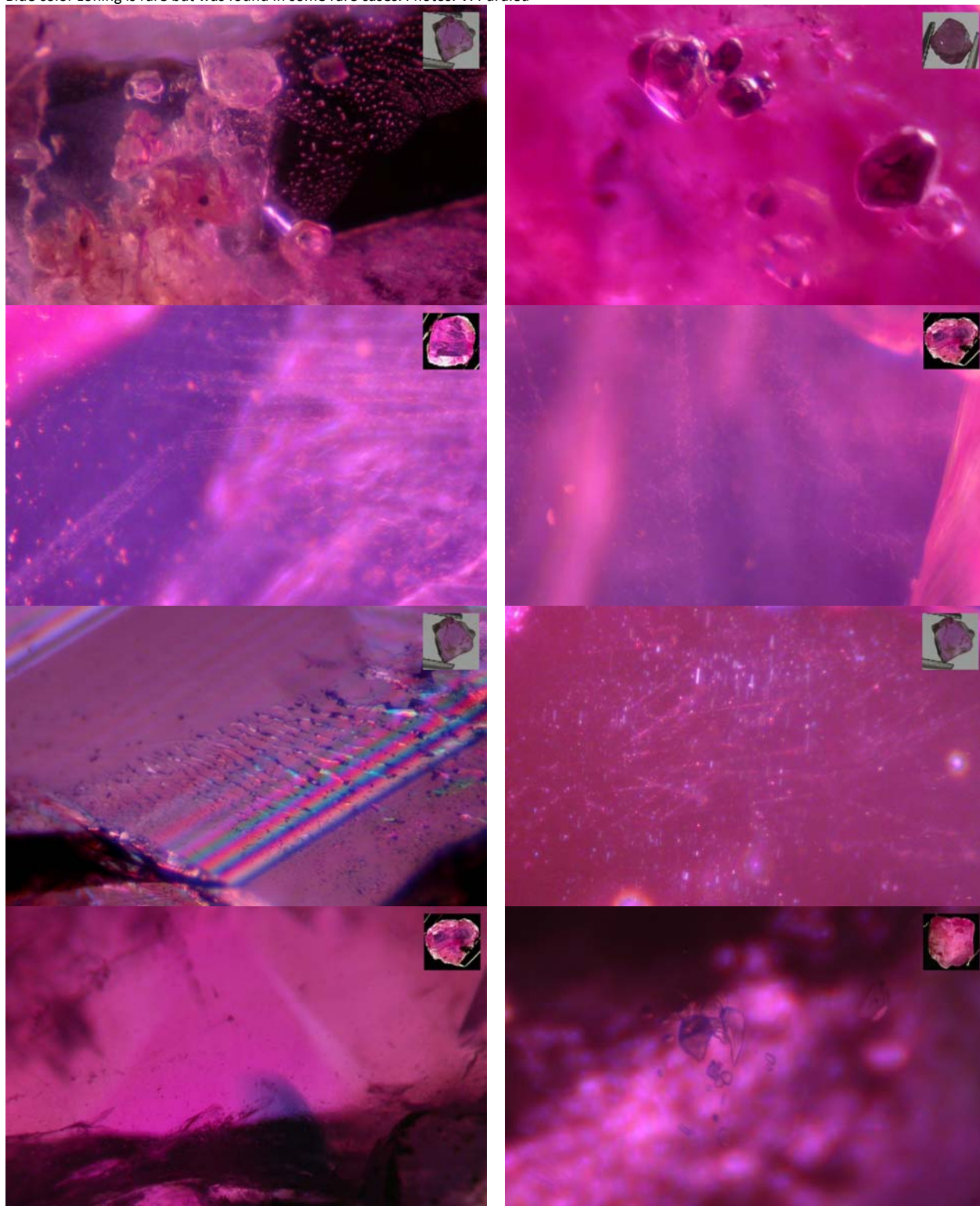
(Part 3) A rapid comparison with inclusions seen in rubies and pink sapphires from Central Asia:

Inclusions in rubies from Jagdalek (Afghanistan), Murgab (Tajikistan), and Nangimali (Pakistan) share a lot of similar features probably due to the fact that these 3 deposits are related to marbles which are associated with fault structures (Garnier, *et al.*, 2006) and result from the same geological event: The Himalayan Orogeny.

Very common inclusions in rubies from all these deposits (including the stones reportedly from Batakundi) are multiple twinning planes (associated commonly with intersection tubes and filled with boehmite), well developed healed fissures, clouds and stingers of composed of minute particles and colorless rounded carbonate crystals. Blue color zoning is very common stones from Jagdalek (Bowersox, 2000) and Tajikistan (Smith, 1998, Pardieu, 2006) but is rare in rubies from Nangimali. On the other hand pyrite inclusions are very common in Nangimali rubies and rare (but still not uncommon) in stones from Jagdalek. Finally, negative crystals associated with flat equatorial reflective structures seem to be very common in Tajikistan rubies but very rare in rubies from either Jagdalek or Nangimali.

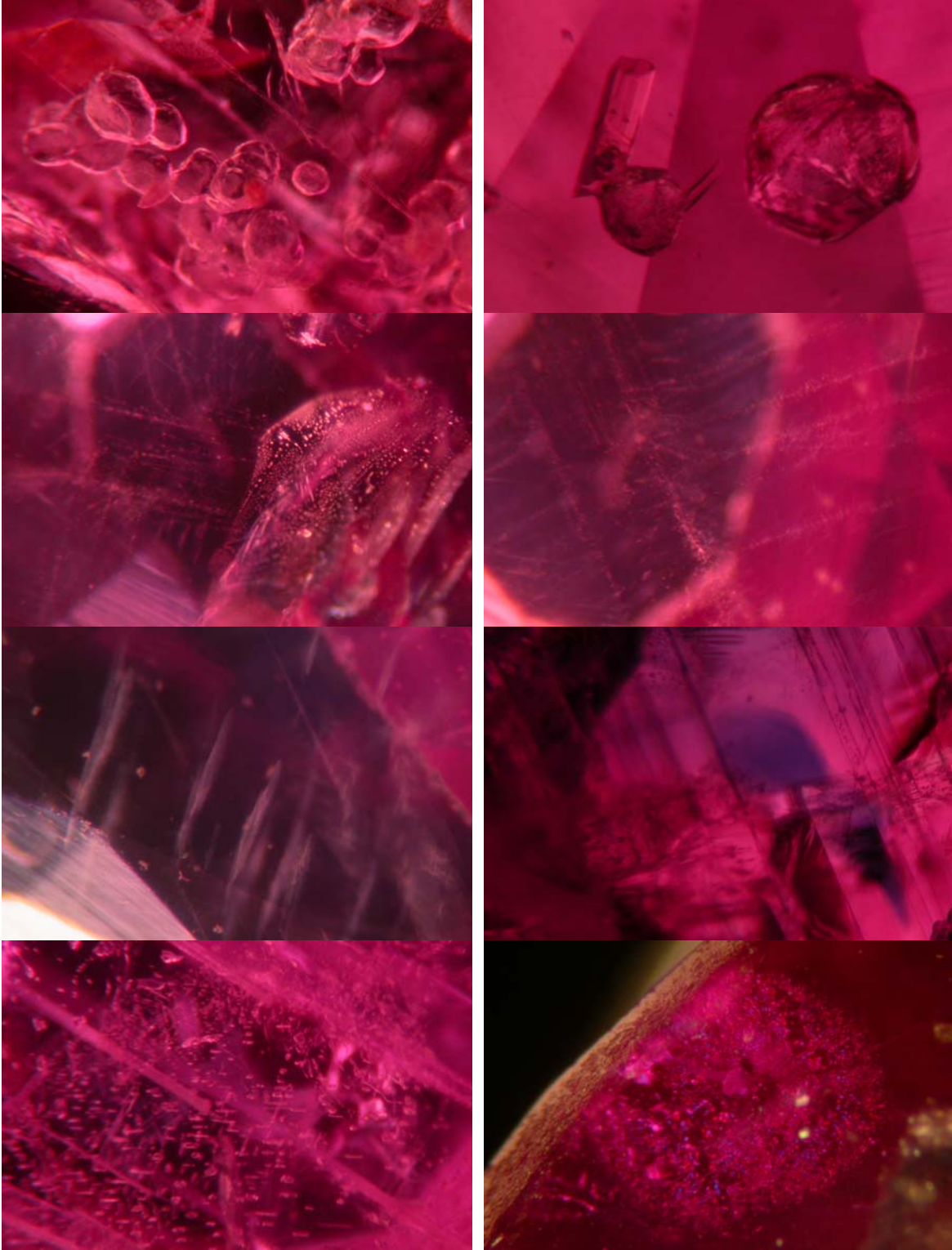
Inclusions in rubies from Nangimali (Pakistan controlled Kashmir):

Table 13: Typical inclusions in Nangimali rubies: Pyrite and carbonate crystals are commonly seen in association with healed fissures, minute particles in bands or stringers, clouds of tiny needles, twinning planes commonly intersecting forming tubes eventually filled with boehmite. Blue color zoning is rare but was found in some rare cases. *Photos: V. Pardieu*



Inclusions in rubies from Jagdalek (Afghanistan)

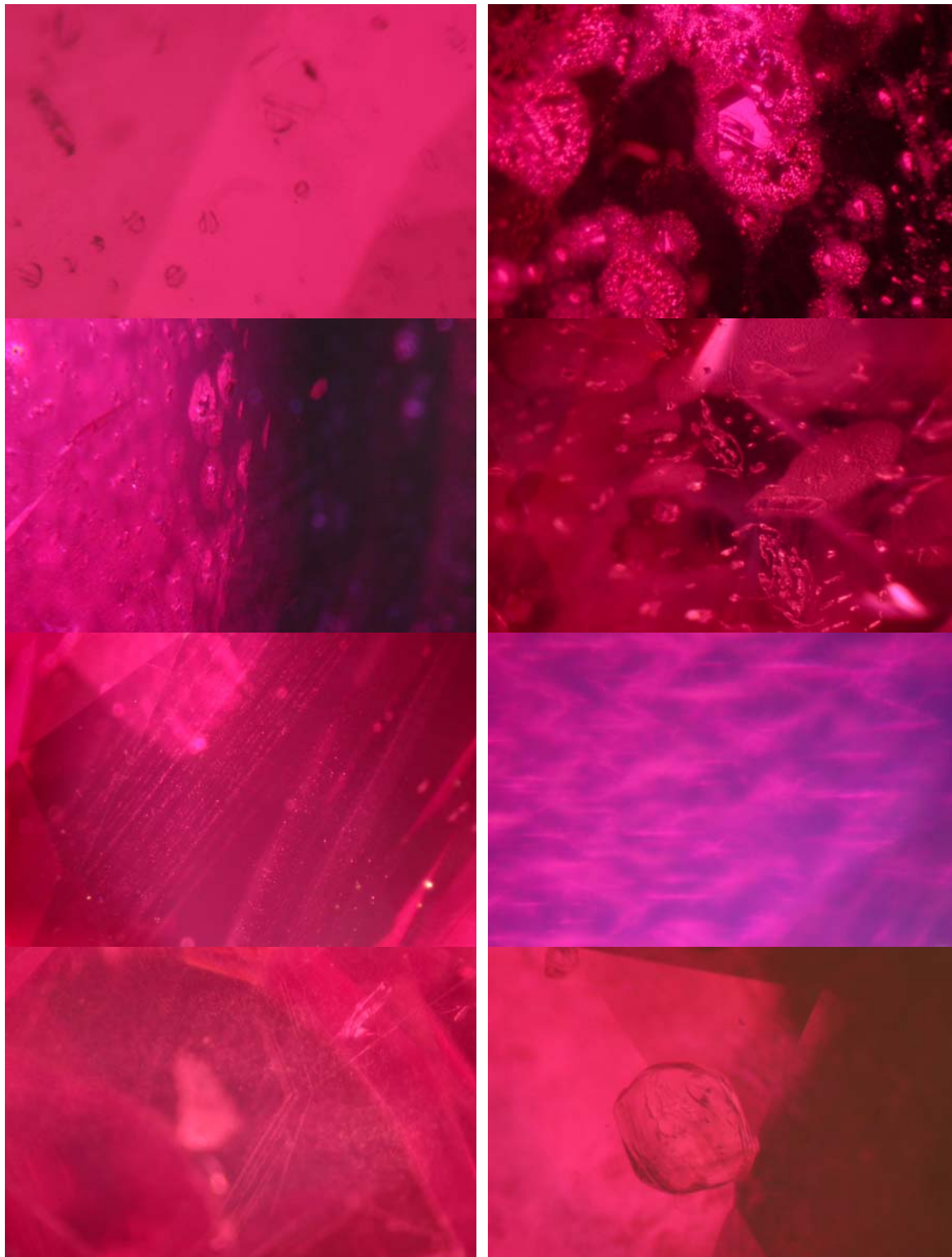
Table 14: Typical inclusions commonly found in Jagdalek rubies: Colorless rounded carbonate crystals, minute particles forming bands, stringers or whitish flakes, healed fissures, blue color zoning, twinning planes intersecting each other associated with intersection tubes commonly filled with boehmite. In some rare cases opaque dark crystals eventually associated with healed equatorial disk can be found. *Photos: V. Pardieu*



Inclusions in rubies from Murgab (Tajikistan)

Table 15: Typical inclusions found in Tajik rubies: Planes of tabular negative crystals associated with “rosette” like reflective equatorial healed fissures, blue color zoning, colorless rounded carbonate inclusions, healed fissures, minute particles or tiny needles forming stringers, bands or flake like structures. The stones commonly display a turbid milky blue aspect using fiber optics.

Photos: V. Pardieu



Conclusions:

The gemological analysis performed at the GIA Laboratory Bangkok in April 2009 on the submitted pink-purple sapphires with a reported origin of “Batakundi – Basil” area in Pakistan controlled Kashmir reveal that this material is different in many aspects with what is known from the other ruby and sapphire mining areas in Central Asia. The gemological properties of this material is matching perfectly with the three stones in Figure 5 that were obtained from an independent source and reported to have been mined in Pakistan.

Sadly, as the VP was not able to visit the Batakundi mining area in 2006 and then failed to collect reference samples on site which could fit with the GIA’s 99% Certainly Rules. It is not possible to confirm that such material was indeed mined at Batakundi, nevertheless the result of our gemological studies and the information we have from several independent sources point to Batakundi as the most probable origin for these stones.

This study besides the description of an unusual sapphire material reflects the difficulties commonly encountered by gemological laboratories regarding origin determination of gemstones. With the multiplication of ruby and sapphire mining areas in Africa and Asia in the past decades and the fact that many of these sources are located in areas difficult to access, many of these deposits were not studied or even described. This is particularly true for those which have only a very small production like the Batakundi deposit in Pakistan controlled Kashmir. Stones from such deposits can be a true challenge form gemological laboratories due to the lack of data.

As a result it is an important first step to document carefully any unusual gem material for research purposes. Such preliminary work will be useful to Lab and Field Gemologists facing similar material. In the near future, hopefully, a GIA field gemological team will visit again Central Asia and possibly will succeed to visit the Batakundi area, collect samples at the source which will enable the completion of this preliminary study. Building, studying and updating an origin related gemstone reference collection is nevertheless a long term project, possibly a never ending project. But stone after stone we advance in knowledge and day after day we will be able to provide a better service.

Acknowledgements:

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References:

Bowersox, F., Laurs, Shigley, Smith. (2000) Ruby and Sapphire from Jagdalek, Afghanistan. *Gems & Gemology*. 36 No2. Summer 2000. 110 - 126.

Clutterbuck, G. (2009) Pers. Comm.

Emmett, J. (2009) Pers. Comm.

Garnier, V.(2003) Les gisements de rubis associes aux marbres de l'Asie Centrale et du Sud Est: Genese et caracterisation isotopique. Ph.D. Academic, Department, INPL Nancy, France

Garnier, V., Ohnenstetter, D. and Giuliani, G. (2004) L'aspidolite fluoree: Role des evaporites dans le genese du rubis des marbres de Nangimali (Azad-Kashmir, Pakistan). *Comptes Rendus Geoscience*. 336. 14. 1245-1253.

Garnier, V., Maluski, H., Giuliani, G., Ohnenstetter, D. and Schwarz, D. (2006) Ar-Ar and U-Pb ages of marble-hosted ruby deposits from central and southeast Asia. *Canadian Journal of Earth Sciences*. 43. 4. 509-532.

Gübelin, E. J. (1982) Die Edelsteinvorkommen Pakistans - 1. Die Rubine aus dem Hunzatal. *Lapis*. 7. 5. 19-26.

Hughes, R. W., Pardieu, V. (2006) Moon Over the Pamirs: Chasing Ruby and Spinel in Tajikistan www.ruby-sapphire.com

Kane, R. E. (1997) Kashmir ruby - a preliminary report on the deposit at Nangimali, Azad Kashmir, Pakistan. *26th International Gemmological Conference - Abstracts*. 28-30.

Okrusch, M., Bunch, T. E. and Bank, H. (1976) Paragenesis and petrogenesis of a corundum-bearing marble at Hunza (Kashmir). *Mineralium Deposita*. 11. 3. 278-297.

Pardieu, V. (2006) Summer 2006: Gemmological expedition report to Ruby, Emerald and Spinel mining areas in Central Asia, Part 1: Pakistan: A field trip to the Central Asian capital of the gemstone trade. www.fieldgemology.org

Pardieu, V. (2006) Summer 2006: Gemmological expedition report to Ruby, Emerald and Spinel mining areas in Central Asia, Part 2: Afghanistan: Land of beautiful gems and unique people. www.fieldgemology.org

Pardieu, V. (2006) Summer 2006: Gemmological expedition report to Ruby, Emerald and Spinel mining areas in Central Asia, Part 3: Tajikistan:Gems from the Pamirs. www.fieldgemology.org

Pardieu, V. (2006) Rubies from Tajikistan. www.fieldgemology.org

Pardieu, V. (2007) Tajikistan, Gems from the roof of the world. *InColor magazine* Spring 2007 27 -30

Pecher, A., Giuliani, G., Garnier, V., Maluski, H., Kausar, A. B., Malik, R. H. and Muntaz, H. R. (2002) Geology, geochemistry and Ar-Ar geochronology of the Nangimali ruby deposit, Nanga Parbat Himalaya (Azad Kashmir, Pakistan). *Journal of Asian Earth Sciences*. 21. 3. 265-282.

Piat, D. (1974) Le rubis himalayen d'Hunza. *Bulletin de l'Association Française de Gemmologie*. 41. 5-7.

Quinn, E., Laurs, B.M. (2004) Sapphires from Afghanistan and Pakistan. *Gems & Gemology*. XL. Winter 2004. 343 - 344.

Smith, C. P. (1998) Rubies and pink sapphires from the Pamir Mountain Range in Tajikistan, former USSR. *Journal of Gemmology*. 26. 2. 103-109

Annex 1: Introduction to GIA's sample collecting protocols.

Gemology has become over the years more scientific and technical, it is then logical that a special care is taken regarding the way reference samples are collected. Collecting samples should be also performed following a strict scientific methodology, meaning that the whole process should be fully and properly documented.

The 3 main rules regarding the way samples are collected followed by GIA Field Gemologists are:

- 1) Collect samples as close a possible from the source: An "A type" sample is better than a "B type" sample, etc...
- 2) Collect samples from at least 3 reliable and independent sources: Even an "A type" sample should get confirmed by other samples collected from other independent and reliable sources.
- 3) To document fully and honestly all the process regarding the way samples are collected (movies, photos, GPS data, notes...)

Two separate databases to store both **Origin-Specific** and **Origin-Opinion** data are in development at GIA: The database of **origin-specific stones** shall only contain stones in which the degree of certainty on their country of origin is 99% or better. All data from stones with a less than 99% certainty shall be stored in the **origin-opinion** database.

The 99% origin-certainty rule:

Stones with 99% origin-certainty are those that have been retrieved in-situ or have been retrieved from an operating jig, or other type of mechanical or primitive washing plant, as part of a mine run by the Field Gemologist (Type A or B of GIA's Cataloguing classification).

Another situation where a stone may pass the 99% origin-certainty rule is when a stone or stones are purchased from a miner at the location of the mine, e.g., what is stated to be the results of several days mining (Type C); and following detailed laboratory examination they are found to match, in every aspect, material from 2 other trustable and independent sources that has been retrieved in-situ or from an operating jig as part of a mine run from the same area.

In the case of stones present in GIA's old collection (any type) this rule may not be relaxed with the exception of the involvement of the Field Gemologist. If stones in the old collection were obtained from traders away from the mining area concerned but who gave exact origin locations that can be fully demonstrated, e.g., where the properties of a stones match (well within the outer markers) in every way (optical,

chemical and inclusions) material that fulfills the 99% rule for the stated origin, these and only these would be acceptable as stones with 99% certainty of origin.

The 3 independent-sources:

Regarding building an Origin Specific Gemstone Reference Collection, the first difficulty is that only God and the miner know where a gemstone is really from: God does not speak to gemologists and gemologists should not trust all what the miner could say... In gemological laboratories, one of the rules of proper gem identification is to confirm the results provided by an instrument with at least another instrument. Collecting samples in the field should follow the same wise laboratory methodology:

Thus the best way to collect samples is to always collect samples from at least 3 different and independent sources.

Possible / probable samples:

When mining areas are very difficult to access and thus when samples complying with the 99% origin-certainty rule cannot be obtained, the “3 independent sources” rule is even more important: Stones collected from a single reliable source (type E or F of the GIA cataloguing system) should be tagged as “possible”.

“Possible” samples can become “probable” if we can find at least 2 other independent and trustable sources providing stones matching in every way (optical, chemical and inclusions) that possible material and of course if the information about the samples provided by the 3 independent and trustable sources are matching.

The Verification Committee:

“Probable” samples which match in every way with material that fulfills with the 99% origin-certainty rule might then be acceptable as stone with 99% certainty of origin if they are accepted by the “verification committee”. For the stone to be accepted all the members of the committee shall be confident in the integrity of the specimen and the data collected before agreeing to its inclusion in the origin-specific database.

A simplified version of GIA’s cataloguing classifications:

Stones complying with the 99% Origin Certainty rule:

- **“A Type Stone”**: The stone was mined by a GIA Field Gemologist.
- **“B Type Stone”**: The stone was collected on site at the mine from the miners and a GIA Field Gemologist witnessed the mining process.

Stones collected at the mines but not in accordance with the 99% Origin certainly rules:

- **“C Type Stone”**: A GIA Field Gemologist collected the stone from miners, at the mine but without witnessing the mining process.

“Possible” and “probable” samples not collected at the mines:

- **“D Type Stone”**: A GIA Field Gemologist collected the stones from the miner, but not at the mines”.
- **“E Type Stone”**: A GIA Field Gemologist collected the stones from a secondary trustable source close to the mines (like a local gem market)
- **“F Type Stone”**: A GIA Gemologist collected the stones from a secondary trustable source in the international market (trade show, etc...)

Stones with no trustable information available:

- **“Z Type Stone”**: No information about the conditions the stone was collected or stone collected from a poorly trustable source.