Rubies Reportedly from the Niassa Region of Mozambique

A preliminary examination

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Figure 1: Unheated faceted and rough rubies weighting from 0.9 to 5.4 carats for the faceted stones and believed to have been mined from Niassa province of Mozambique. The oval stone, first row, on the right might in fact originate from Winza, Tanzania. Stones courtesy: J&W Gems. *Photo: V.Pardieu*

Introduction:

During the past few months, new rubies reported as "Mozambique" appeared in the market in Bangkok and Chanthaburi: After some enquiries in Thailand, Tanzania and Mozambique it seems that this new material is coming from an area near the famous Niassa National Park in Northern Mozambique.

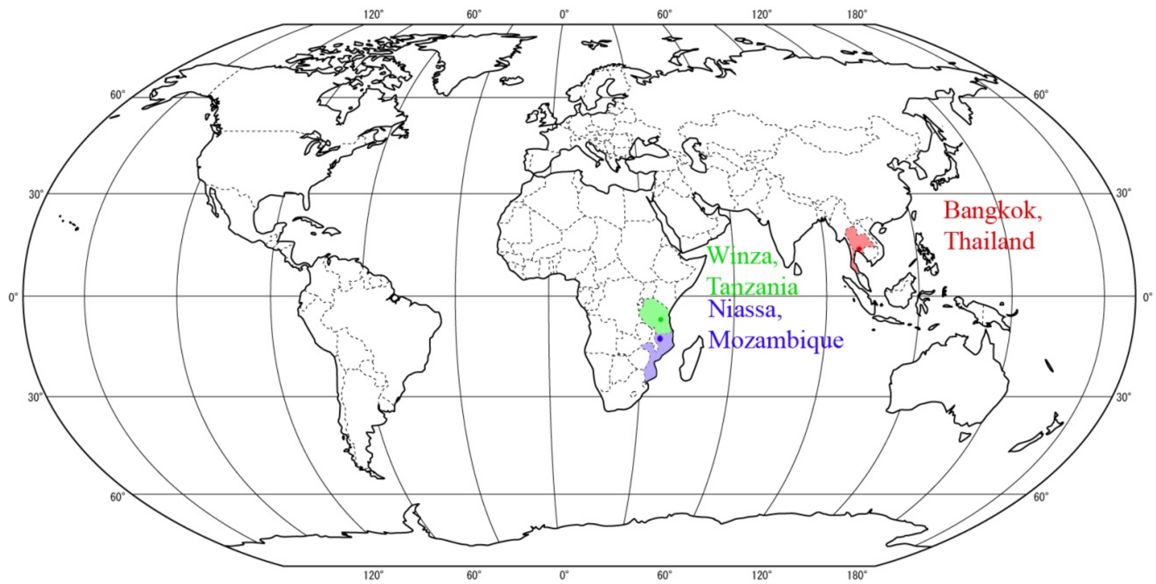

Figure 2: The Niassa province is located in the North West of Mozambique, close to the Tanzanian border. The new ruby deposit is expected to belong to the famous "Mozambique Belt" of East Africa, a complex geological region hosting many gem deposits producing rubies, sapphires, garnets, spinels, emeralds, tanzanite,… Many East African gemstones are then exported to Bangkok in Thailand where the author first saw some of them. Map: V.Pardieu/GIA Laboratory Bangkok, 2009

At the end of October 2008, Tanzanian broker Abdul M'sellem informed one of the authors (VP) that some new unknown material quite similar to the Winza stones but from another origin probably in the south of Tanzania started to be available in the Mpwapwa gem market, located near the Winza mining area in Tanzania. M'sellem reported that some Tanzanian gem dealers recently started to travel to Songea and Namtumbo to get these stones. After further enquiries, at the end of November, A. M'sellem was able to locate the new deposit in Mozambique near Lichinga, the capital of the Niassa province in the north of Mozambique in an area bordering the famous Niassa National Park.

As the ruby supply from Winza has reportedly become scarce, the new material was welcomed by Thai and Sri Lankan gem dealers that had buying offices in Mpwapwa. Within a few weeks VP was informed that many Winza miners moved to the new deposit while several important buyers moved their office from Mpwapwa to Songea in order to buy the new material but also more traditional Songea and Tunduru gems.

In December 2008 VP (who is *Supervisor of Field Gemology* at GIA Laboratory, Bangkok) visited the Chanthaburi and Bangkok gem markets to find and study the new rubies reported to him by

A.M'sellem from Tanzania. Rapidly several ruby parcels of probable Mozambique origin could be studied in market conditions and 10 unheated rubies reported as "Mozambique rubies" were taken to the GIA laboratory Bangkok for examination. The stones were provided by Wilarwan Thongtham from A&W Gems Company (www.winzaruby.com) in Chanthaburi, a company VP met in April 2008 in Tanzania while visiting the Winza ruby deposit. The current report is of a preliminary study on these rubies collected in the Thai market. These results will of course need to be confirmed by the study of samples collected on site, at the source, in the future. The GIA Laboratory Bangkok is currently preparing an expedition to the new Niassa mining area in Mozambique and other sources of interest in East Africa, in order to collect reference specimens.

On March 05, 2009, an article on Internet http://allafrica.com/stories/200903050910.html brought an official confirmation that ruby mining became important recently in the Niassa region of Mozambique: It reported (March 05th 2009) that illegal ruby mining in Niassa province was on the agenda at a meeting in Maputo organized by the *Mozambique Ministries of Mineral Resources and of the Interior* on "*Implementation of Mining Legislation and its Main Constraints*". It was also reported that the Mozambique government has sent a team from the *National Directorate of Geology* to undertake a survey at M'sawize to establish the size of the ruby deposit and that some stones had been seized from illegal miners and traders.

As the new mining area is located in the Niassa region, we decided to use in the present report the short-form "*Niassa ruby*" to describe these gems also commonly called in the trade "Mozambique ruby". The fact is that Mozambique, as other in countries of the gem rich Mozambique belt, probably host several ruby deposits and thus the use of "Mozambique ruby" might be confusing in the future, on the other hand it is also interesting to associate a beautiful gem with the famous Niassa National Park using the name "Niassa ruby".

Availability of Niassa rubies in Thailand gem markets

Rubies reported from the Niassa region in Mozambique are available in Bangkok and Chanthaburi as unheated stones, but also either as flux heated or lead glass filled material. Unlike the Winza stones it seems that the low quality Niassa material is suitable for heat treatment either using the flux or lead glass technologies depending on the quality of the rough. In both cases the results look promising as the treated stones seen by VP in the Thailand gem markets look attractive. Faceted unheated stones from 0.5 to about 3 carats and heated rubies up to 15 carats were seen in the market. Glass filled stones up to 20 carats were also available. Larger stones heated or not up to 50 carats were reported but the authors had no chance to study them. The fact that low quality material can be turned into attractive stones using Thai treatment technology (flux or lead glass) is something which can be seen as promising for the future of the deposit as it means that miners will find markets not only for the small percentage of high quality material, but also for the rest of their production thus miners might get more regular revenue and mining activity may remain for a longer period. The conditions will then be present for exceptional stones to be found from time to time.

The study of rough samples in the market was interesting. The rough reported from Niassa was composed mainly of fractured crystals with rare crystal faces visible, most of the stones were heavily fractured, and no stones were presenting the water-worn or dissolved aspect respectively typical of alluvial and basalt related type deposits. A Thai dealer reported to VP that the new deposit in fact consists of several different areas and that the deposit is not really new; he said that it was known for many years but it seems that the recent interest for Winza rubies could be the reason for the “rediscovery” of these rubies from the Niassa region. At first glance the stones look quite similar to the Winza material.

Figure 3: Lead glass filled rubies reported from Mozambique (Niassa) origin seen in Bangkok market, the stones range from 7 to 15 carats. Stones courtesy: Mahiton Thondisuk, *Photo: V.Pardieu*

Gemological description of the Niassa ruby material:

Gemological studies on the 10 unheated rubies provided by A&W Gems Company were performed at the GIA Laboratory, Bangkok by the authors. The unheated nature of the stones was confirmed by microscopic examination and spectroscopy.

The material used for the study was from pink to red and dark red and were representative of the Niassa rubies seen in the Thai market. They are often dark in tone but some stones were a very attractive bright red and clean. Compared to the Winza rubies (which are sometimes mixed with Niassa rubies) Niassa rubies are often less transparent; probably due to their silk inclusions. Blue color zoning, a common feature in Winza material, was not noticed in the current Niassa samples.

Generally speaking the visual appearance of Niassa rubies is reminiscent of Thai-Cambodian gems and of other iron rich rubies from East Africa; like those from Winza and Umba in Tanzania, from Baringo and Simba in Kenya, and from Madagascar and Malawi.

Thus rubies from the Niassa area can be easily be separated from the iron poor marble type ruby deposits from East Africa like those of the Tsavo area in Kenya or the Mahenge and Matombo areas of the Morogoro province of Tanzania and from the other marble type rubies resulting from the Himalayan Orogeny like those from Burma, Vietnam, Tajikistan, Afghanistan, Pakistan, Nepal.

Chemistry

The chemistry of the rubies from the Niassa 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 Niassa rubies. Their chemistry is characterized by high levels of iron and low levels of Ga, Ti and V; quite similar to what is established for rubies from Winza in Tanzania (Schwarz D., 2008).

Table 1, Table 2 and Table 3 set out the determined Ti, V, Cr, Fe and Ga concentrations for three reportedly Niassa rubies of slightly differing colors from pink to pinkish red and bright red.

Table 1: Pink Niassa ruby, 2.326cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.07	bdl*	0.125	0.336	0.005
elemental ppmw	41	bdl*	855	2618	38
elemental ppma	17	bdl*	335	955	11

***** bdl-below detection limit

Table 2: Dark pinkish red Niassa ruby, 2.28cts

units	Ti	V	Cr	Fe	Ga
oxide wt %	0.0077	0.000	0.371	0.282	0.004
elemental ppmw	46	0.0	2540	2191	29
elemental ppma	19	0.0	996	800	8

Table 3: Bright red Niassa ruby, 0.956cts

Units	Ti	V	Cr	Fe	Ga
oxide wt %	0.009	0.000	0.484	0.296	0.004
elemental ppmw	54	0.0	3314	2304	30
elemental ppma	23	0.0	1299	841	8

UV Fluorescence

The 10 rubies 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 was found to be similar to known iron rich rubies from other known deposits like Thailand/Cambodia, Madagascar, Malawi, Kenya and Tanzania (see Table 4).

Table 4: Long-wave and short-wave ultraviolet fluorescence

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

UV-Vis-NIR Spectrometry

The UV-Vis-NIR spectra were collected on the 10 samples studied at GIA laboratory, Bangkok using a Perkin Elmer Lambda 950 UV/Vis Spectrometer and its appropriate accessories. The spectra are dominated by Chromium and Iron absorptions (Figure 4) with Cr3+ absorption bands around 405–410nm, 465/480 nm and 560 nm. The absorptions at 468, 475 and 476 are known as the "B" lines (Emmett, 2009). They result from absorption from the ground state of Cr3+ to the 2T2g level which is split into three components by the spin orbit interaction and the trigonal field (Figure 5).

The absorption peak around 388nm is related to the absorption of single Fe3+ ions. In addition, the spectra generally displayed a strong “background absorption” starting around 600 nm and increasing toward the UV edge as it was also observed for the Winza material (Schwarz D., 2008). The Cr “doublet” at 694 nm was visible in all spectra.

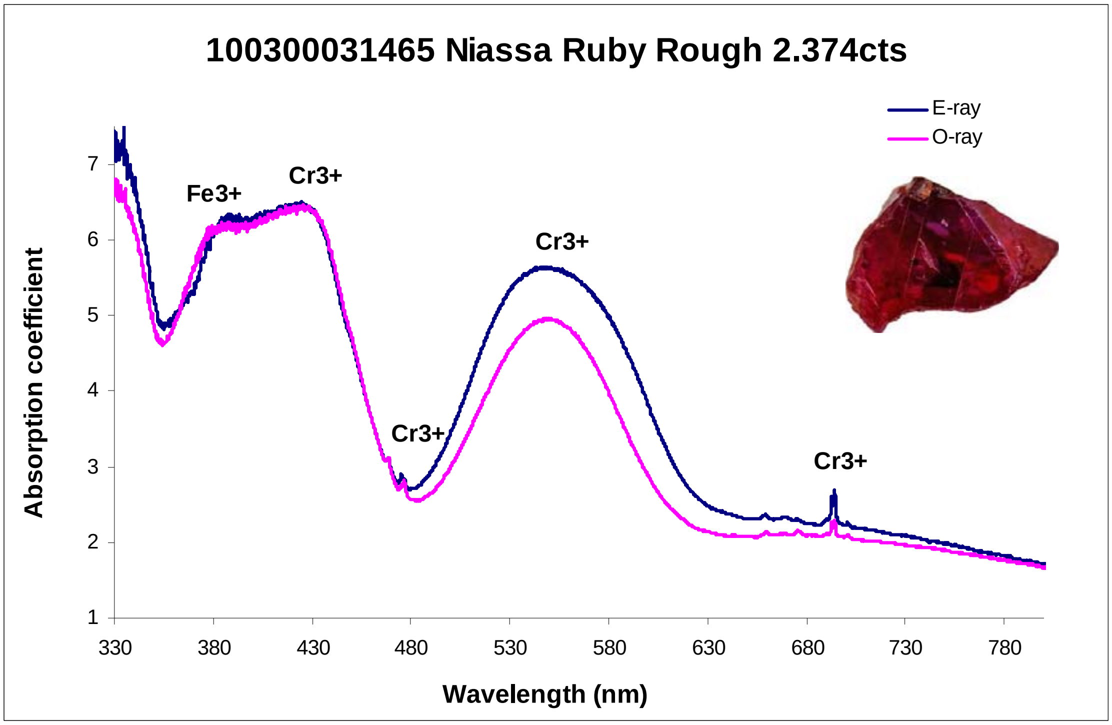

Figure 4: A typical UV-Vis spectrum of rough ruby from Niassa, Mozambique.

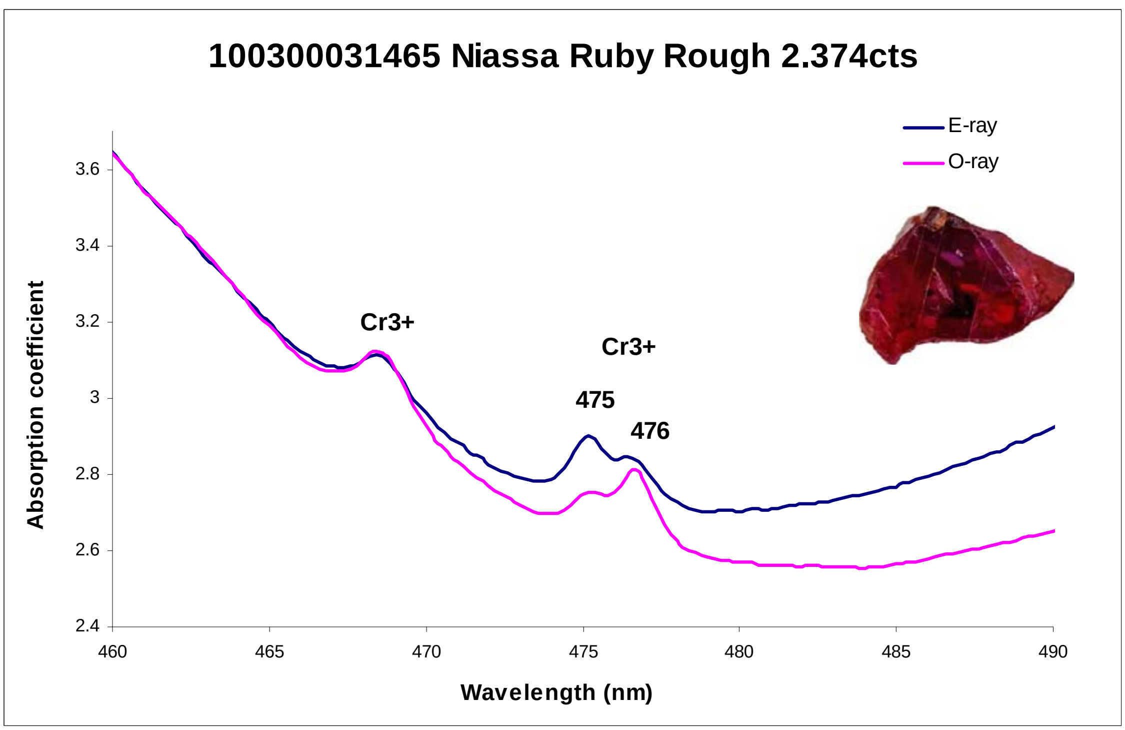

Figure 5: UV-Vis: Details on the Cr3+ related peaks around 475-476nm showing some good dichroism.

Infrared spectroscopy

Infrared spectra were collected using a Thermo Nicolet 6700 FTIR[1] and appropriate accessories.

In most of the unheated Niassa rubies we studied two large absorption bands around 3081cm-1 and 3312cm-1 were present (Figure 6). These may be attributed to the boehmite present within the intersecting tubes associated with twinning in the Niassa rubies examined. The presence of such a boehmite related IR spectrum is a good indication that the stone has not been heated. However, in clean material only a small peak at 3309cm-1 was recorded (Figure 7).

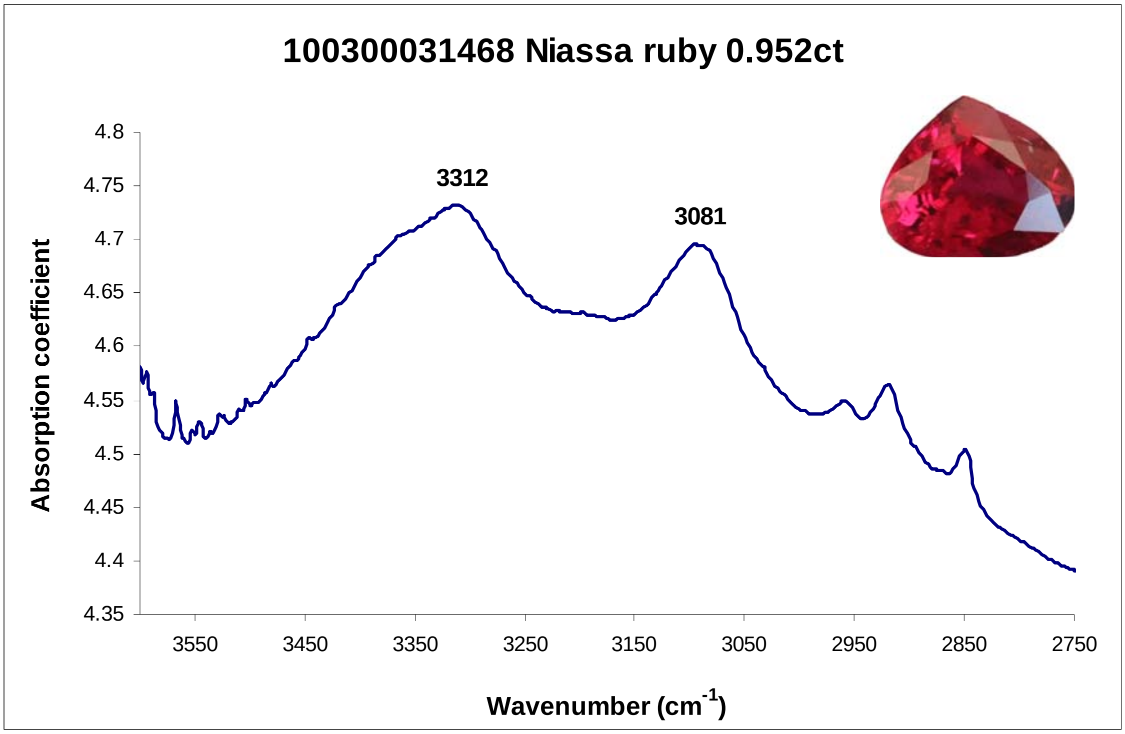

Figure 6: FTIR spectrum of a Niassa ruby with Boehmite filled intersection tubes associated with twinning type inclusions.

[1] FTIR: Fourier Transformed Infra-red spectrometry

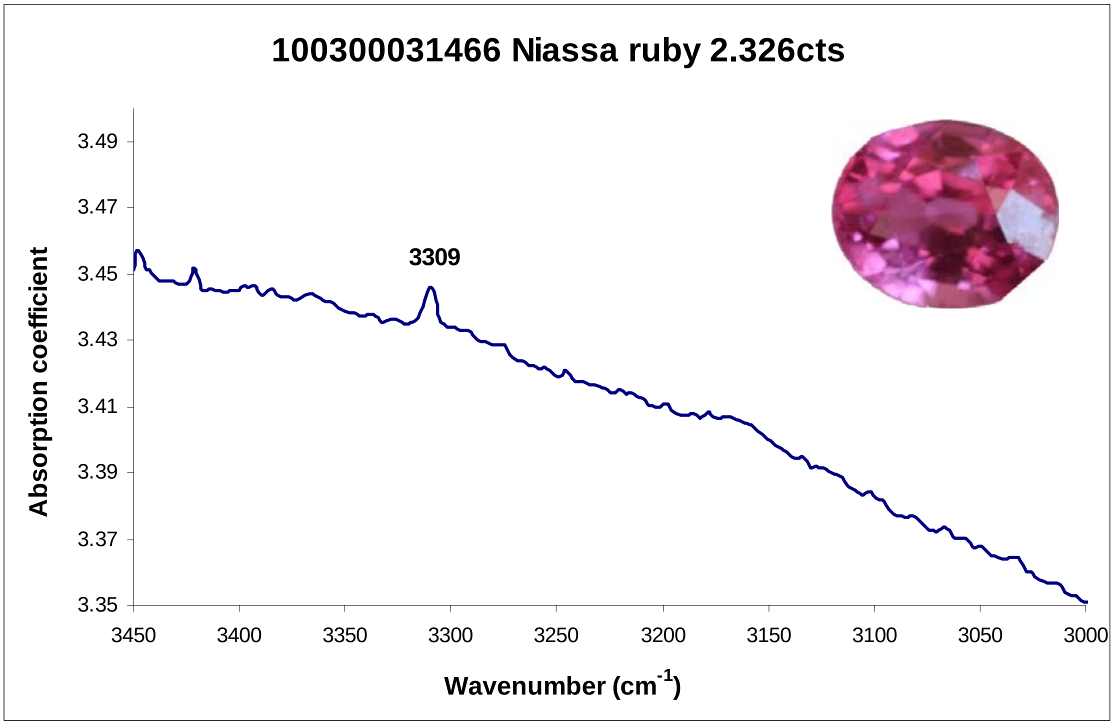

Figure 7: Details on FTIR spectrum of a 2.326 cts unheated pinkish Niassa ruby.

It is interesting to note that in one bright red stone with a peak at 3160cm^{-1}, commonly seen in unheated Winza material, was found (Schwarz, 2008, Schwarz D., 2008). The stone (see Figure 1) had no visible inclusions and its chemistry fell within the Winza ruby range. As both Winza and Niassa rubies are purchased in the same trading centers in Tanzania and then sorted and faceted in Thailand, the presence of a Winza ruby in a parcel reported to originate from the Niassa region in Mozambique should not be surprising. The stone owner: Wilarwan Thongtham, from A&W Gems Company, confirmed that in the Tanzanian trading centers the gems were purchased by her father from many miners/brokers coming from different areas and then commonly sorted by appearance and type more than based on their actual origin. Thus she was not surprised when VP reported to her that GIA gemologists suspected that one of the stones supplied to the lab was probably from Winza and not from Niassa.

This illustrates the difficulty gemological labs face when collecting specimen to study from gem markets: It is not without risks and in fact a visit to the mining area is still the best solution to build a reliable reference collection.

Microscopic examination

Microscopic examination was performed in Chanthaburi and Bangkok markets using a 10x GIA instruments dark field loupe and at GIA laboratory Bangkok 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.

The first global characteristic which can be reported so far for Niassa rubies are that the stones looks very different from the Asia and African iron poor marble related rubies and quite different from the traditional iron rich basalt related rubies like those from Thailand, Cambodia and Kenya, but Niassa rubies share some similarities with rubies of metamorphic origin from other known East African deposits like Winza and Umba in Tanzania and Chimwadzulu in Malawi.

The stones presented in the Thai market as "Mozambique rubies' and which probably origin from the Niassa region present an even color distribution, silk and unhealed fissures are very common, but so far no star rubies from Niassa were seen or studied by the authors. The silk observed in Niassa rubies is interesting (see Figure 8, Figure 9 and Figure 10) as it is different from the silk seen in marble type rubies from Asia or African deposits, and quite similar to what can be seen in some other iron rich rubies: The needles orientated in a 60/120 degrees pattern usually look incomplete, broad, long or short, commonly looking like well formed elongated weakly iridescent hexagonal platelets reminiscent of the thin films present in some basalt related rubies.

The numerous unhealed fissures were usually clean and the classic iron stain seen in many gems from alluvial type deposits was not observed, twinning (see Figure 18) was very commonly found, usually associated with intersection tubules filled with boehmite. Crystal inclusions were very rare and while present in two samples studied we were not able to identify them using Raman spectroscopy (see Figure 17, Figure 11). Secondary healed fissures (see Figure 13, Figure 14) were also present in some samples associated in some case with tabular type negative crystals in planes. The secondary healed fissures where mostly perpendicular to the c axis reminiscent of the rosette like structures seen in rubies from Tajikistan or in sapphires from Kashmir. It was interesting to see negative crystals (see Figure 16, Figure 17) containing a multiphase probably polycrystalline substance.

As microscopic examination seems then be a useful resource to separate Niassa rubies from iron rich rubies from other deposits like Winza. A photo gallery (Figure 8 to Figure 19) concludes this initial description of Niassa rubies, *further and more comprehensive data will be published once verifiable material from this locality is obtained and examined*.

Unheated Niassa Rubies Inclusion Photo Gallery:

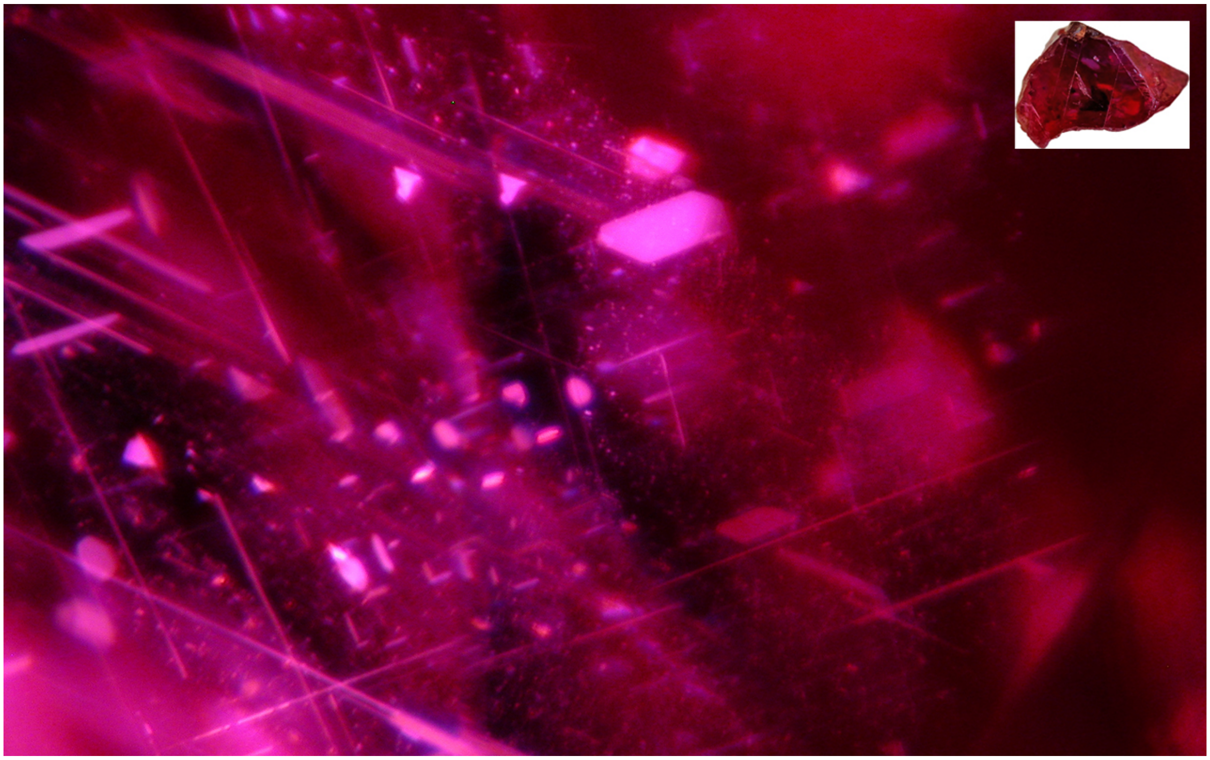

Figure 8: Silk in Unheated 2.374cts Niassa ruby (Dark field illumination, 64x). *Photo: V.Pardieu*

Figure 9, 2009: Silk in 1.054cts Niassa unheated ruby associated with unhealed fissures partially filled with dry foreign substance, probably of natural origin (Dark field illumination, 40x)*Photo: V.Pardieu*

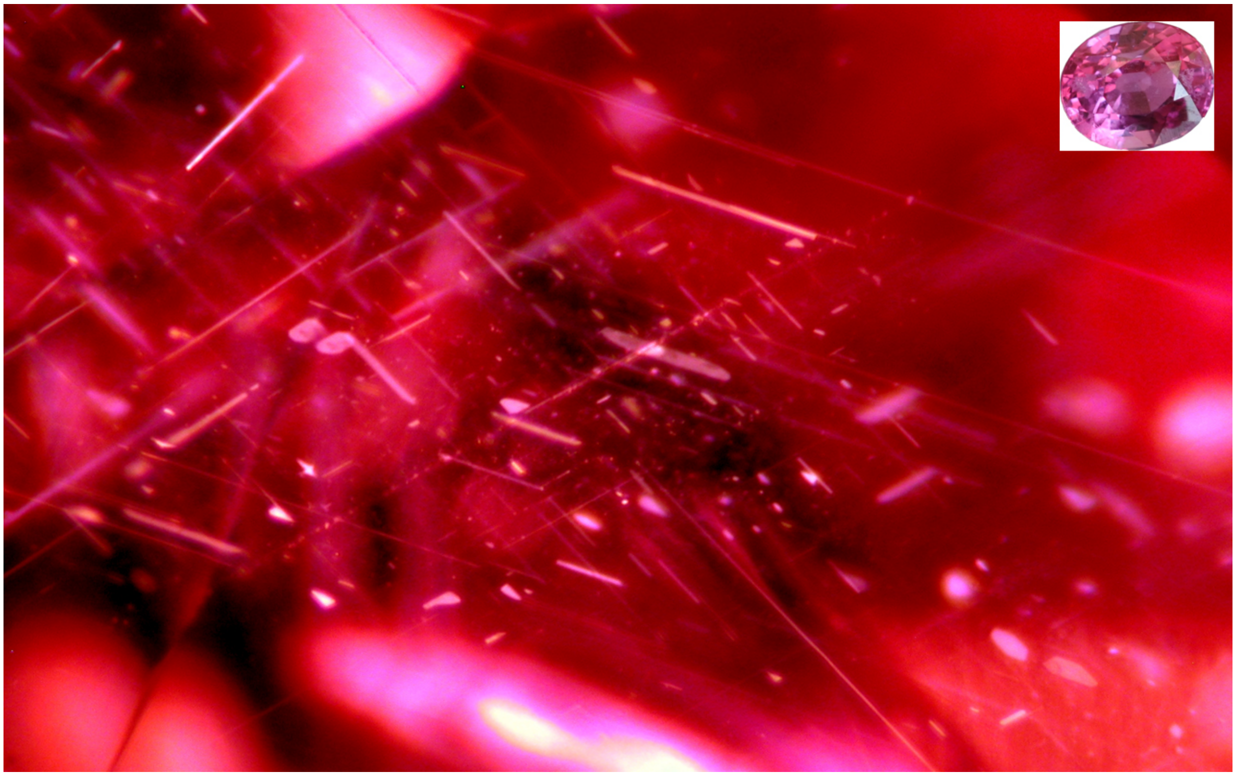

Figure 10: Silk in unheated 2.326cts Niassa ruby: It is clearly composed of elongated or short broad hexagonal like platelets and of long or short needles (Dark field illumination, 50x) *Photo: V.Pardieu*

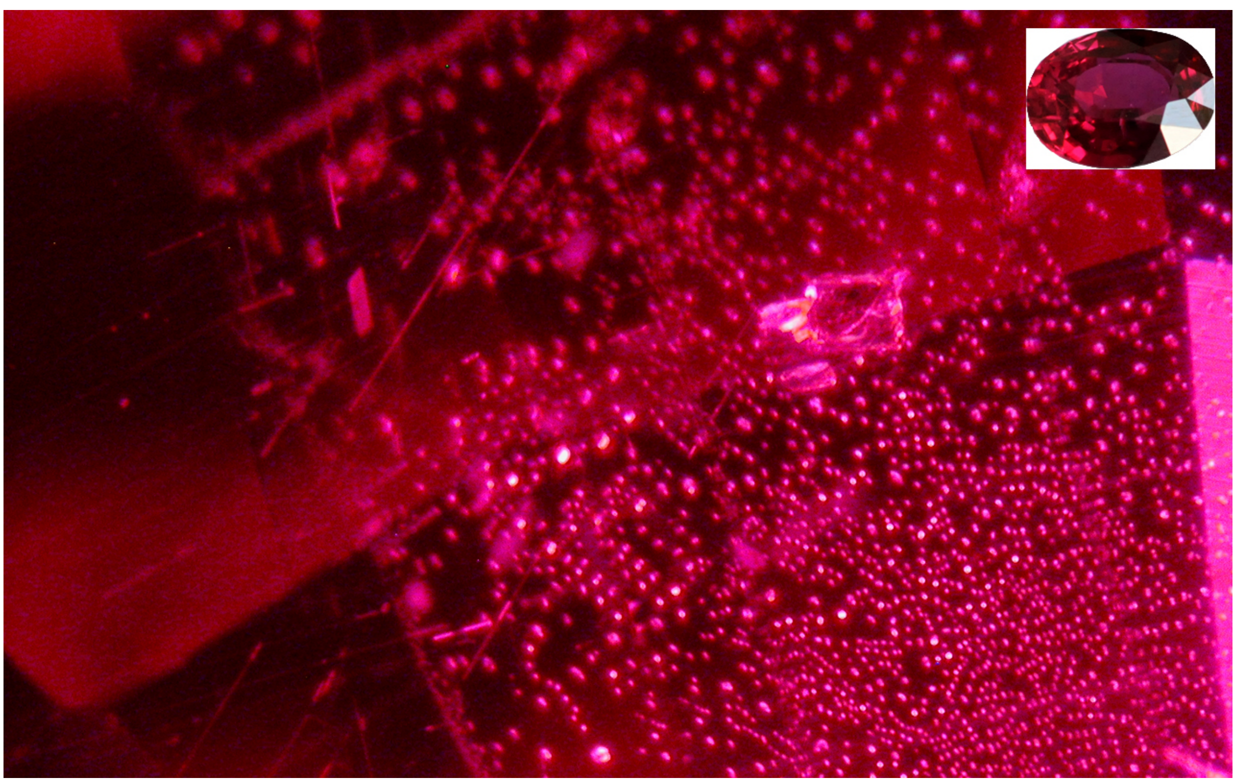

Figure 11: Two colorless, transparent, euhedral crystals of unknown nature associated with silk and a healed fissure in a 2.280cts Niassa unheated ruby. (Dark field illumination, 30x) *Photo: V.Pardieu*

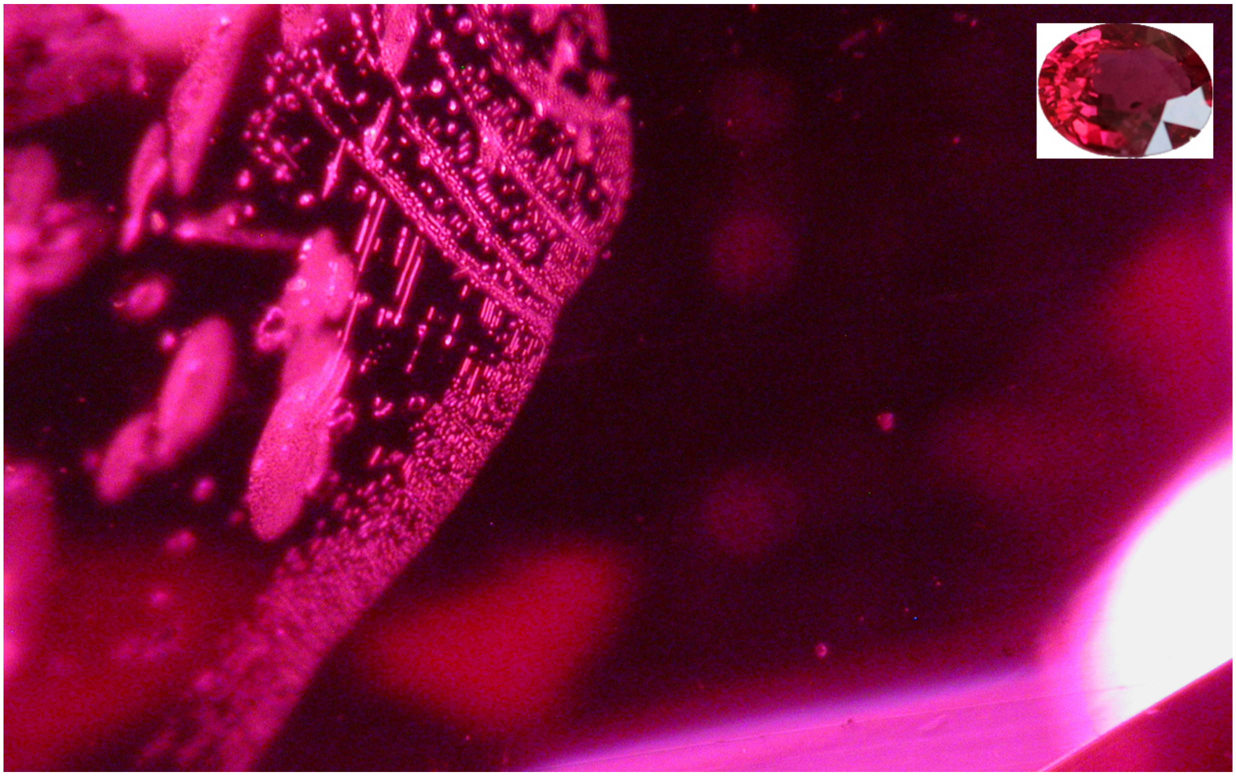

Figure 12: Healed fissure in 1.510cts unheated Niassa ruby seen under dark field illumination (30x), note the negative crystals associated with secondary healed fissures on the left. *Photo: V.Pardieu*

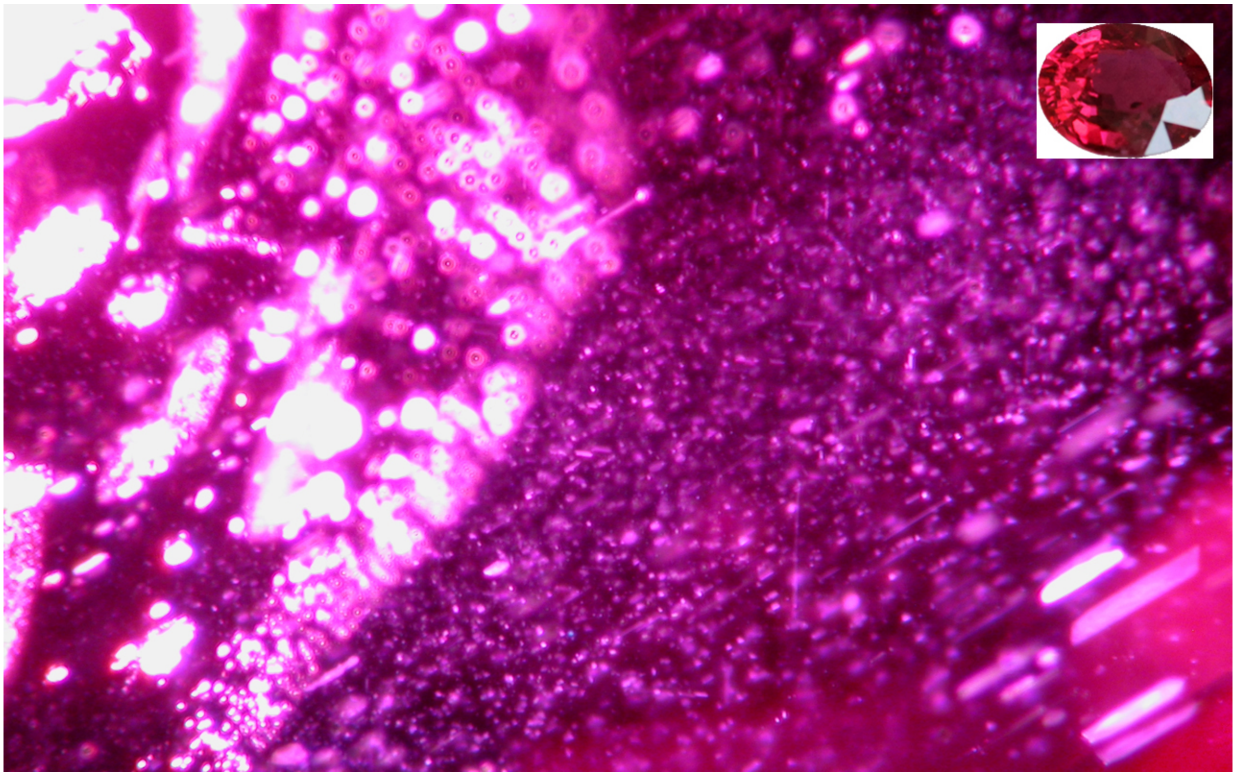

Figure 13: The same stone in the same position but this time using fiber optics illumination (30x): a galaxy of particles and needles, orientated perpendicular to the c axis, is now clearly visible. *Photo: V.Pardieu*

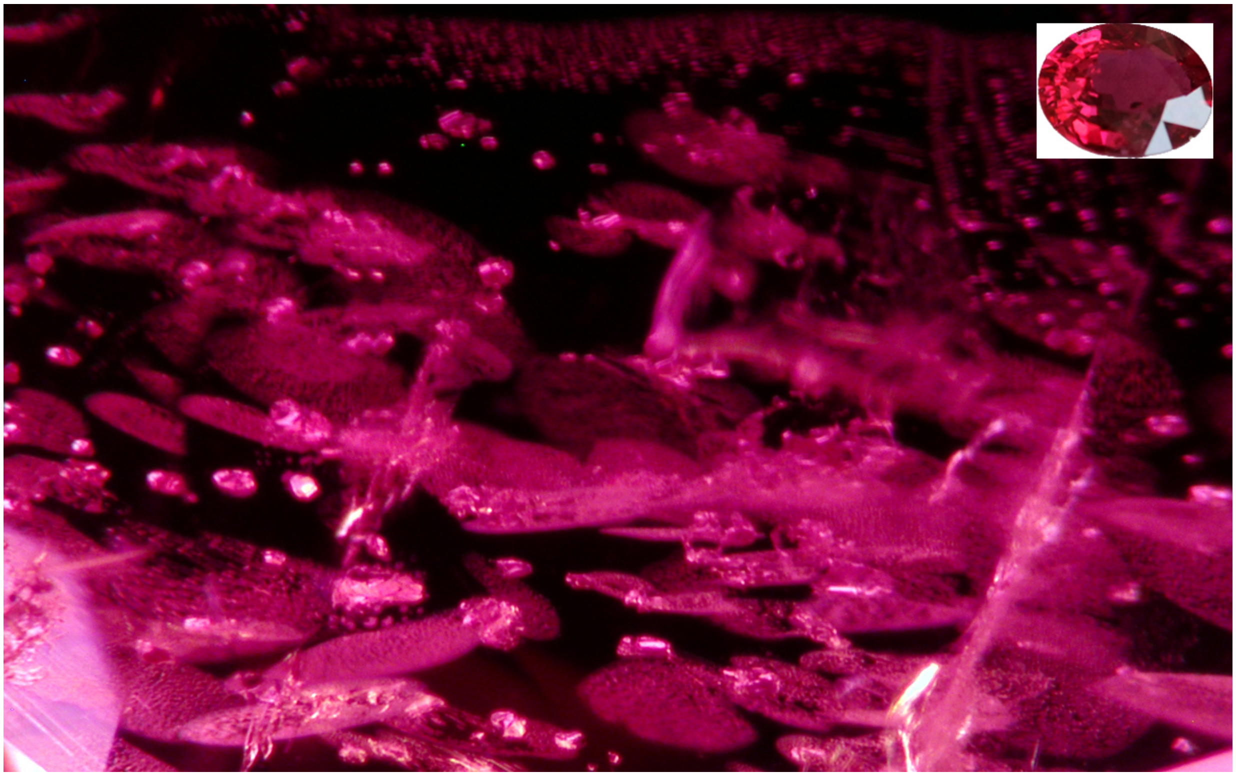

Figure 14, 2009: Plane of negative crystals associated with secondary healed fissures in a 1.510cts Niassa unheated ruby. (Dark field illumination, 30x) *Photo: V.Pardieu*

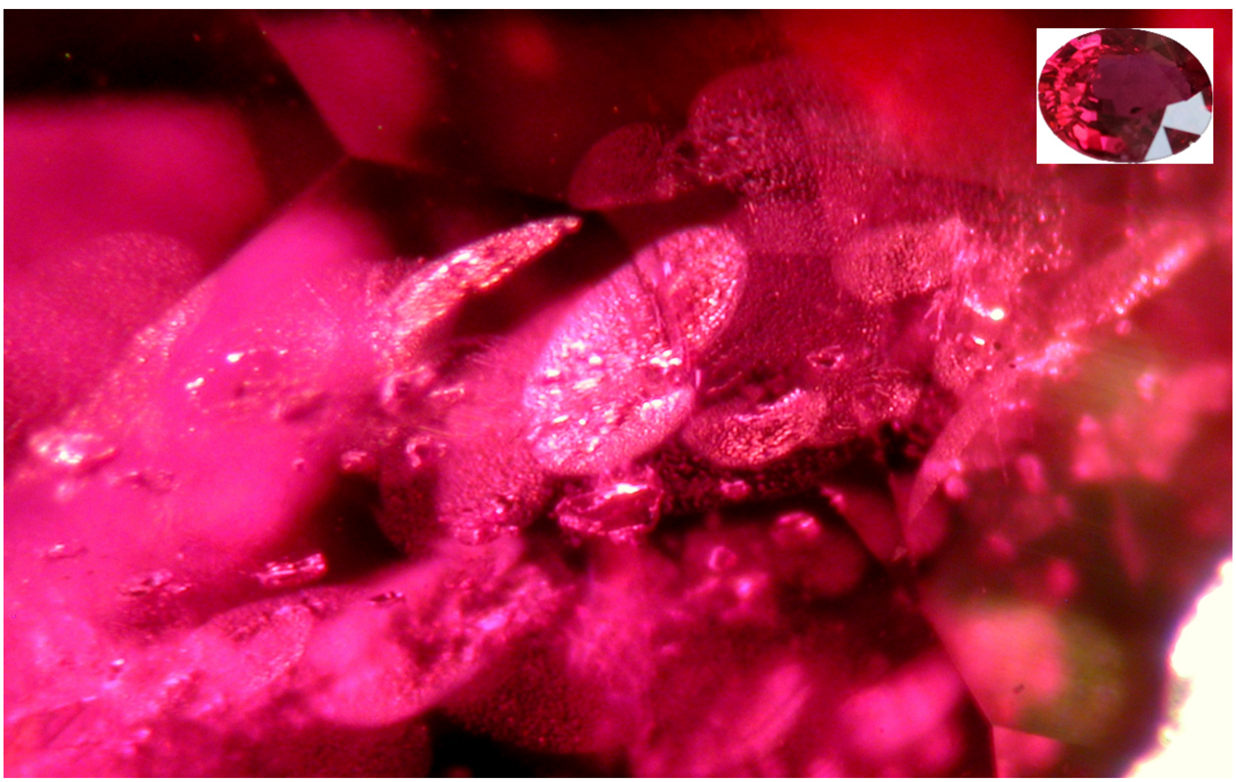

Figure 15: Negative crystals associated with healed fissures orientated more or less perpendicular to the C axis (Dark field illumination, 30x) in 1.510cts unheated Niassa ruby. *Photo: V.Pardieu*

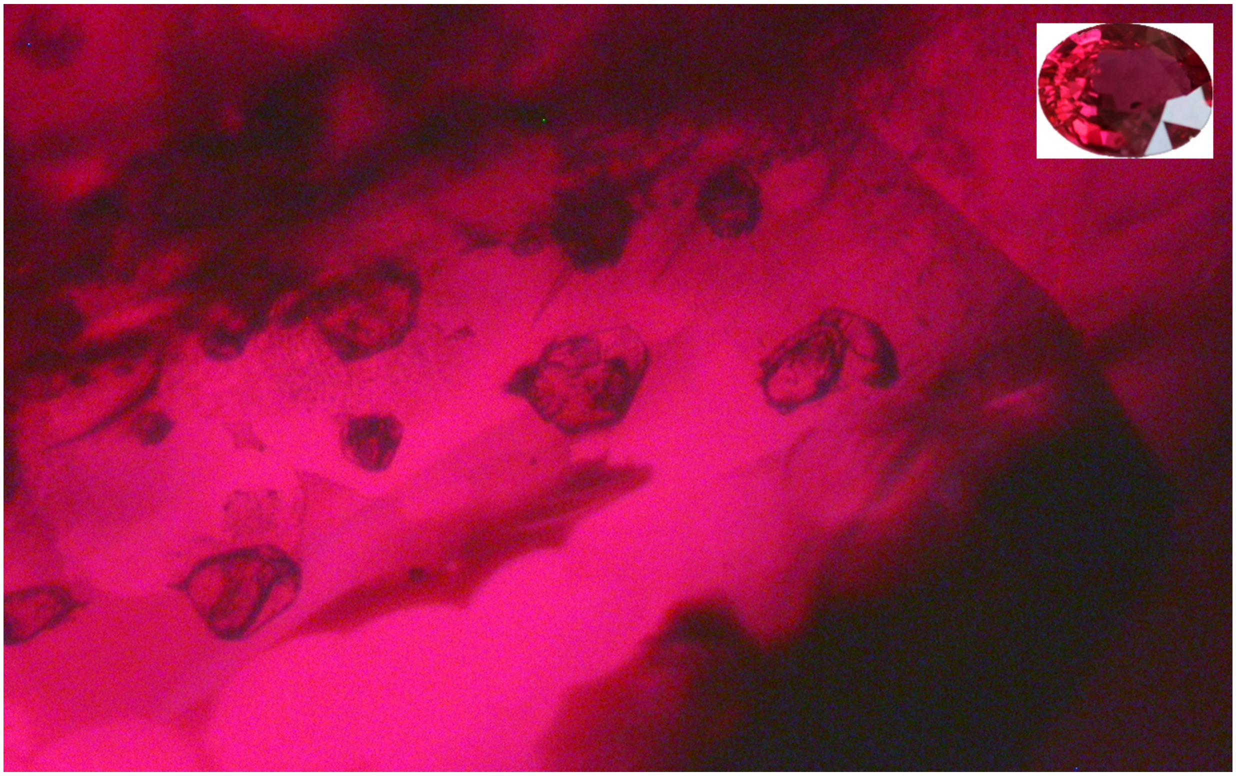

Figure 16: Negative crystals in unheated 1.510cts Niassa rubies seen under bright field illumination (64x) *Photo: V.Pardieu*

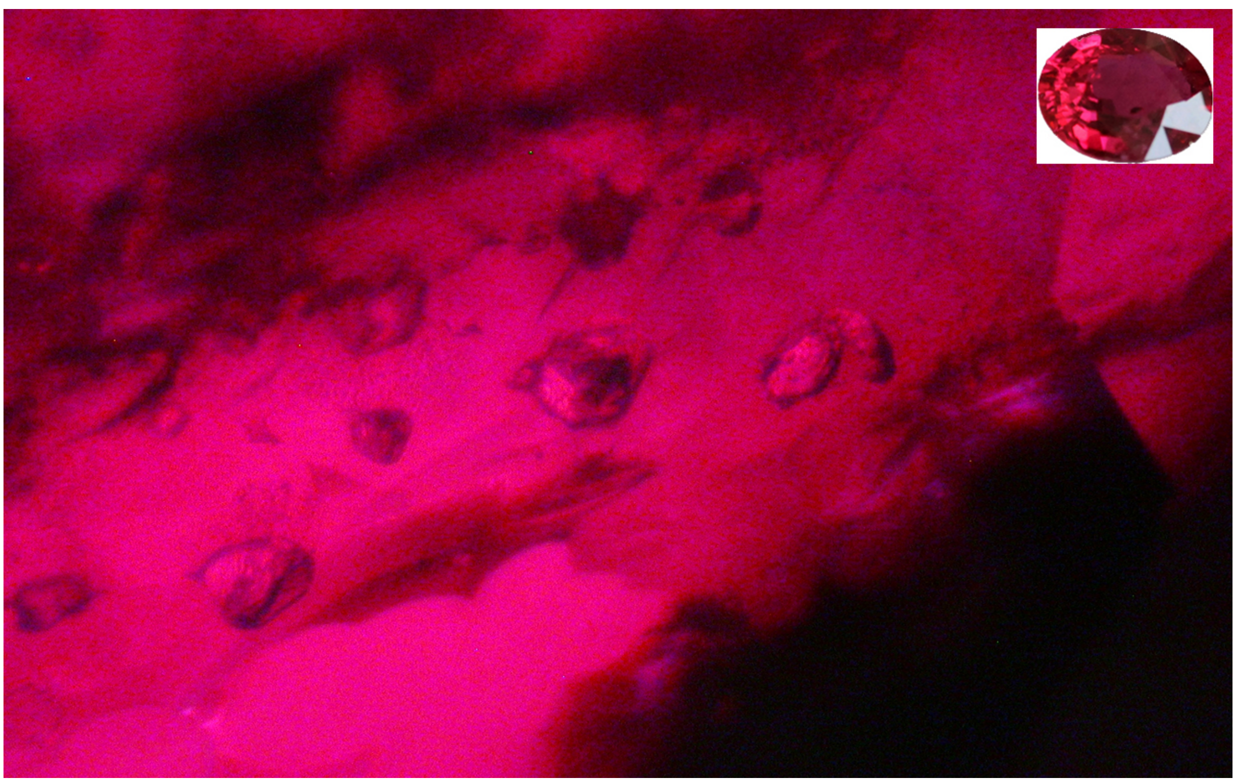

Figure 17: The same stones as in the previous photo but seen using cross polars (64x). The negative crystals appear then filled with a polycrystalline substance. *Photo: V.Pardieu*

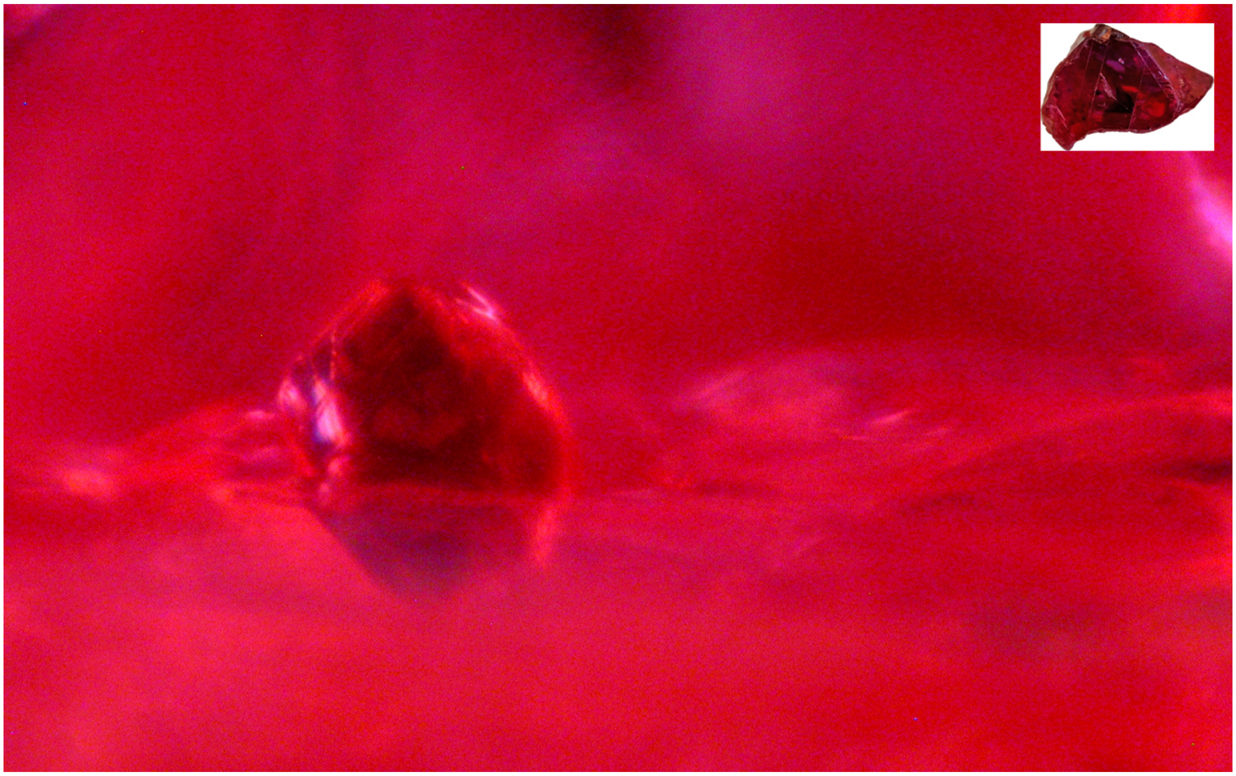

Figure 18: A Black opaque rounded crystal inclusion in an unheated 2.374cts Niassa ruby (Dark field illumination, 64x). *Photo: V.Pardieu*

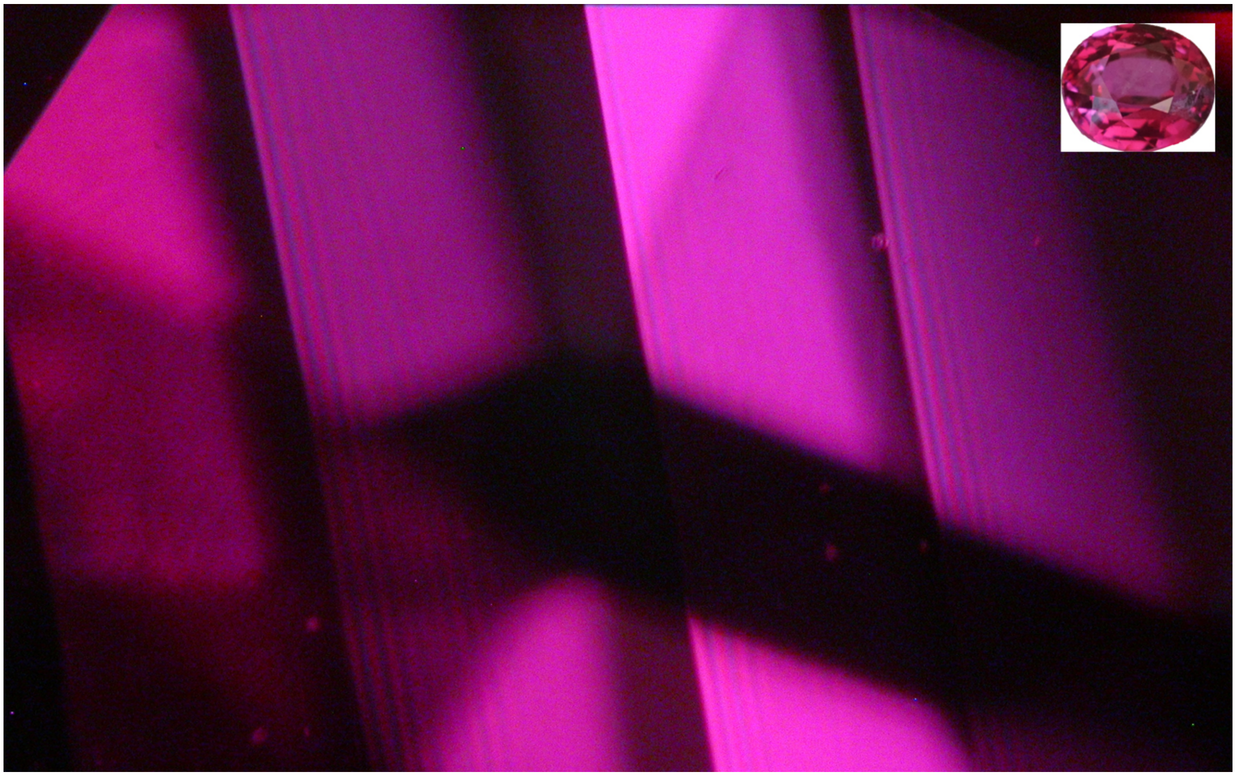

Figure 19: Twinning seen in a 0.989cts Niassa ruby (Cross polars illumination, 40x): *Photo: V.Pardieu*

Acknowledgements

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