Where Are We Going? Trends and Challenges in Gemmology Now and in the Future

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作者簡要地論述寶石學未來的發展，並指出主要的三個寶石領域的重點發展: a)寶石的源頭測斷，b)寶石處理的檢測，c)人造寶石的鑑證。

This article is based on the presentation, given by the author at the 1st Herbert Smith Lecture, organised by the Gemmological Association of Great Britain Gem-A on 19th September 2008 in Hong Kong.

The beauty of gemstones has attracted mankind since the beginning of human history. Archaeological findings in all ancient cultures have revealed that jewellery played an important role in society, not only for its beauty, but also as a sign of power or social status and as a link to mythical and religious belief.

Although virtually everything about the way we all live has changed tremendously since these early times, it is quite striking to see that the reasons why we wear jewellery and how we apply it, and even its design, have not changed that much during all that time.

Starting from this point, I would like to present a brief look into the future of gemmology, especially focusing on trends which will challenge our work as gemmologists in the years to come.

Fig. 1 Do we see the future in this rock crystal sphere? © H.A. Hänni, SSEF

Gemstones:

Talking about gemstones, we can locate three major fields in which we will see changes challenging our work as gemmologists: a) origin determination of gemstones, b) detection of treatments and c) identification of synthetic gemstones.

a) Origin determination:

"There is always something new out of Africa" Pliny the Elder, 23 A.D. - 79 A.D.

Every gemstone has an origin. Apart from the visual beauty of the stone, its origin is a source of emotion and inspiration for people. To answer the demand for this information, origin determination is and will remain a highly specialised service offered to the trade by gemmological laboratories.

Gemstones are minerals, found in primary or secondary deposits which have a finite operational viability. When a deposit is exhausted it will be abandoned. This has already happened to many deposits famous for gemstones in the past (e.g. Kashmir sapphires, Kunene spessartines) and will certainly happen to deposits currently still productive. But as new deposits are discovered (e.g. copper-bearing tourmaline from Mozambique, rubies from Winza in Tanzania) the future does not look grim but rather prosperous in terms of gemstone supply.

Fig. 2 Untreated ruby (11 ct) of excellent quality from Winza, Tanzania. @ H.A. Hänni, SSEF 2008

When it comes to origin determination, however, the situation becomes more complex with every new deposit which produces gemstones for the trade. When origin determination as a lab service was first practiced by Edward Gübelin in the 60s (see also Gübelin & Koivula 1986) and later further developed by Henry A. Hänni and the Swiss Gemmological Institute (see Hänni, 1990 and 1994), the main sources of corundum were a few classic deposits. This situation has become much more challenging with the discovery of large findings, especially those made in East-Africa and Madagascar in the 90s. Origin determination never was and never will be easy, but requires considerable experience and well-trained expert knowledge. For the future, gemmologists who want to practice origin determination will have to have a sound understanding of the

geological setting of gem deposits. An extremely informative volume updating current research on gemstone sources has been published recently (Geology of Gem Deposits, Mineralogical Association of Canada Short Course Volume 37, 2007) and is highly recommended. Coming from this background myself, I hope that future gemmologists will have an extensive and scientific foundation in geology and mineralogy. It is also essential to visit mining sites to understand their geological setting and to have access to a reference collection, which is constantly being updated with samples from new deposits.

Fig. 3 The author visiting a sapphire mine near Chanthaburi (Thailand) together with gemmologists George Bosshard, Vincent Pardieu, and friends. © A. Bosshard, 2007

Origin determination is based on a combination of observations (e.g. microscope, UV-reaction), measurements (e.g. RI, SG), and analyses (e.g. EDXRF, FTIR, UV-vis). Although new instruments (e.g. LIBS, LA-ICPMS) do give us more insight into gemstone properties, I am convinced that the meticulous observation of inclusions within a gemstone will, even in the future, remain the most useful tool for origin determination. The presence, shape and distribution of inclusions is the most sensitive indicator of different geological settings (i.e. different origins); much more so than chemical or spectroscopic features. In future, chemical fingerprinting by mass spectrometry (Guillong & Günther 2001), luminescence spectroscopy, stable isotopes (Giuliani et al. 1998) and age determination, using radioactive isotopes within the gemstones or inclusions will further expand our options.

Fig. 4a

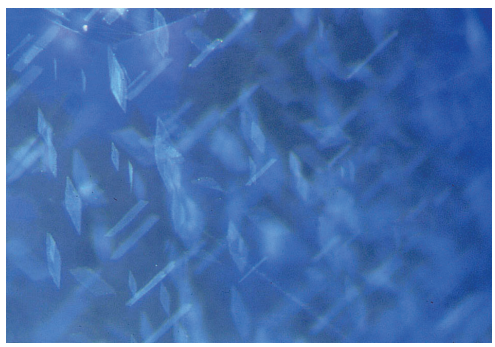

Fig. 4b

Figs 4a and b White, roundish flakes in a sapphire from Kashmir (above) compared with distinctly rhombic flakes characteristic for sapphires from Madagascar (below). Subtle differences in shape may be a strong indicator of a different origin of a gemstone. © H.A. Hänni, SSEF

To summarise, origin determination will be important for part of the trade and so it will remain a sophisticated challenge for future gemmologists (Krzemnicki 2007). Classic deposits such as Kashmir, Burma, Sri Lanka for corundum, Colombia for emeralds, and Brazil for Paraiba tourmaline will remain premium "origin brands" for the trade. Establishing new, important sources as origins of repute will be a question of good marketing.

b) Treatment of gemstones:

"Everything that is possible will be done"

The treatment of gemstones is currently practised on a large scale. Economically it is also important to meet the high demands of the market. This will not change in future. The issue, however, is the disclosure of treatments (CIBJO blue books, www.cibjo.org). As in other industries such as food (e.g. organic or mass produced with chemical additives), aware consumers want to know what they are buying. There also has to be a price difference between these products, so that it is the consumer's decision what to buy. If the jewellery trade, especially in the high-end sector, fails to make proper disclosure, the whole industry will face a dramatic loss of consumer confidence.

The beryllium diffusion of corundum is a typical example of what happens when a new treatment shakes the whole market just because there has been no proper disclosure policy right from the start. It has only been by a concentrated effort by gemmological laboratories that the detection of this treatment has been made possible, and this has meant their investing in new and expensive technologies such as laser induced breakdown spectroscopy (LIBS) and laser ablation inductively coupled plasma mass spectrometry (LA-ICPMS) (see Krzemnicki et al. 2004 and 2007).

The future will see more treatments: simple and cheap ones for cheap stones, such as lead-glass filled fissures in low quality rubies, but also highly sophisticated ones for highly valuable stones, such as HPHT (Chalain et al. 1999) and multiple treatments for diamonds.

Fig. 5a

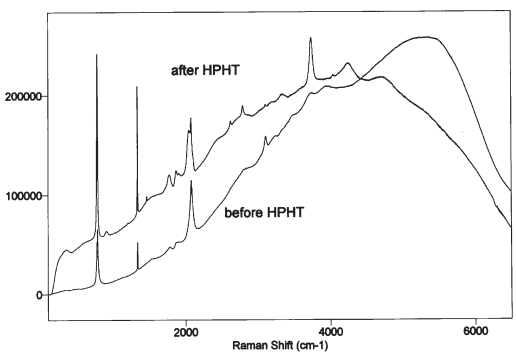

Fig. 5b

Fig.s 5a and 5b
5a: Ia type Diamonds before (top row) and after HPHT treatment (middle and bottom row).
5b: Photoluminescence spectra before and after HPHT treatment.
© H.A. Hänni and J.P. Chalain, SSEF

One treatment that is sure to have an important impact on the market will be *coatings*, as technology in this field (e.g. for optics) has developed tremendously in the last few years (Shen et al. 2007).

For the future two trends will be important for the laboratories. A few laboratories will have the instruments and thus the capacity to identify treatments as far as possible. For many other gemmologists, however, the main question will be simply whether or not the stone has been treated at all. Because the fact will be that if a corundum has been heated, any kind of additive or diffusion might be present but it will not be possible to detect them using only the common tools of a gemmologist.

c) Synthetic stones and imitations:

"Venice or The Venetian? That is the question... "

Every product has its market. This is also the case for synthetic stones. Synthetic diamonds produced by chemical vapour deposition (CVD) in particular will have a major impact in the future, as it is now possible to grow (small) synthetic diamonds quite fast and inexpensively (See references).

As with treatments, the main issue is the correct disclosure of a synthetic stone. Another problem is that synthetic stones may be mixed with natural ones. To identify a synthetic stone is not always easy and may be beyond the scope of the normal gemmologist who does not have access to sophisticated equipment.

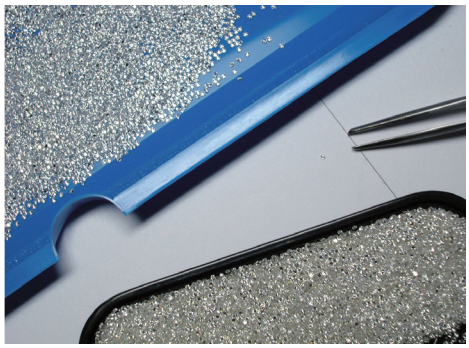

Fig. 6 Small diamonds as they are used by luxury brands for watches and jewellery. Are there any synthetic diamonds, treated diamonds or imitations mixed in with this selection? © H.A. Hänni, SSEF

Synthetic stones generally do not strike the same emotional chord as do natural stones even though in chemical composition, crystal structure and physical properties they are identical to their natural counterparts. So in order to endow a synthetic stone with some emotional 'thrill factor', some companies have started to market their product with a "personal touch". In some cases your DNA (e.g. from a hair) may be added as an inclusion in your stone much as relics of the Saints were preserved in the Middle Ages. Other companies sell synthetic diamonds, which they claim actually to have been formed from the carbon of the hair of a living person, or the ashes of a dead body. Whether this is truly the case or not has – to our knowledge - so far not been proven independently by a gemmological laboratory.

But as we see from a comment taken from a website, such synthetic diamonds are welcome to some people: *"It has helped me so much to have my (diamond) ring on all the time and when it sparkles I feel Bob is smiling at me."*

Imitations (and simulants) are products, which are used as cheaper replacements for gemstones and not necessarily to fool the consumer. But again, the correct disclosure is a *must*. For an experienced gemmologist, they are rarely a threat, but rather show the creativity of the producers or forgers. For the retailer or end consumer, however, they can be very convincing and can make for a very bad investment.

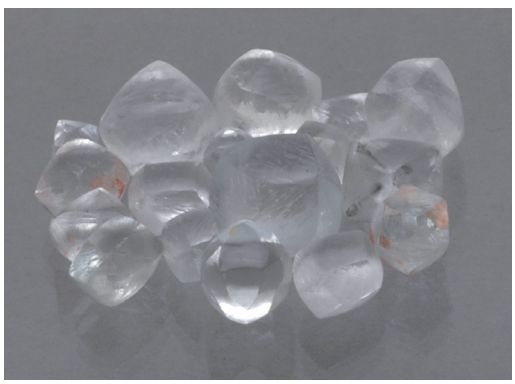

Fig. 7 Beware of topaz cut to imitate rough diamond crystals and sold as diamonds to tourists and retailers. © SSEF, 2008

We see with anxiety how terms are misused purposely to confuse the end user. Especially given the anonymity of the e-market (internet) and television channels, almost no regulations are implemented and low quality stones, or synthetics and imitations are often sold without proper disclosure. International bodies such as the World Jewellery Federation CIBJO are going to become even more important in setting the trade rules; perhaps especially in these new distribution channels for gemstones and jewellery.

Gemmological laboratories:

Finally, I would like to address some thoughts to the future of laboratories testing gemstones. As we have stated above, detection of the origin, treatments, or even synthetic growth will become more difficult in the future. As a consequence gemmology will become more scientific than it has already in the last few years. Gemmology started as a practical application of mineralogy. It will expand more into physics, chemistry, material science, biology and geology. Some laboratories such as the SSEF Swiss Gemmological Institute invest considerable scientific and financial resources in order to be at the frontline of research in gemmology. They are trendsetters, developing new instruments and methods to identify and detect gemstones safely. Even the smaller gemstone dealers can profit from such inventions, such as with the SSEF Diamond spotter, a small and easily used tool to separate type I diamonds from type II diamonds (which may have been HPHT treated).

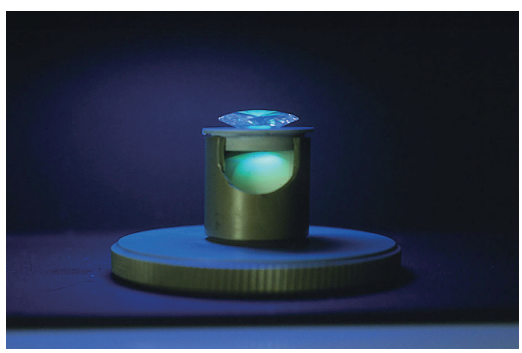

Fig. 8 SSEF diamond spotter (prototype model 2001) showing a green reaction on the screen. The colourless diamond mounted on this spotter is a type II and will need to be tested in a laboratory to determine whether or not it has been HPHT treated. © H.A. Hänni, SSEF

The technological progress made as a result of space missions is one of the driving forces for new analytical methods. What has proven successful in space is certainly useful for gemstone analyses (e.g. LIBS). Especially when it comes to the size and design of instruments, we will see a trend for minimizing in the future, as the recently developed small-scale portable UV-Vis spectrometer shows.

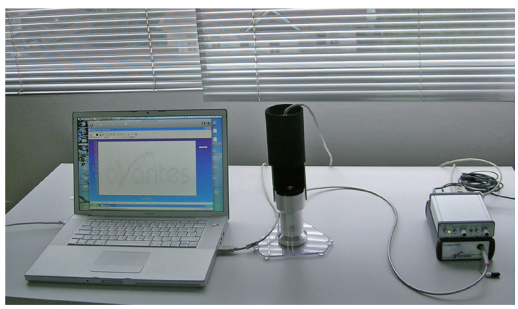

Fig. 9 Portable UV-Vis spectrometer developed by the SSEF Swiss Gemmological Institute. This instrument uses a small spectrometer, which can simply be plugged into a laptop.
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Conclusion of this glimpse into the future:

"In these matters the only certainty is that nothing is certain" Pliny the Elder, 23 A.D. - 79 A.D. Generally speaking, some major laboratories will become "brands" in their own right (even more so than they are today) and this will help to maintain the confidence of consumers in the market, even more than today. Apart from a few all-in-one laboratories, we will see more and more specialist labs, many of them concentrating on grading diamonds (and other gemstones) based on internationally accepted standards. Bearing in mind the complexity of gemstone identification, origin determination, and treatment detection now and in the future, I am convinced that the trade will have to accept that this work cannot be done at the highest level of expertise for just a few dollars per gemstone report.

In the future grading a diamond based on well-defined quality criteria will be able to be done quite inexpensively using a sort of fast-track routine. However, when it comes to highly valuable items, such as a coloured diamond, where colour authenticity is required, or an untreated ruby, where the origin is asked for, we shall still need highly specialised experts and gemmological laboratories equipped with the most sophisticated instruments.

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