Are new sapphires from Sri Lanka diffusion-treated or not?

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Recently the SSEF received four sapphires from 4.56 to 11.11 carats from Sri Lanka. The stones were rather free of inclusions and showed a medium strong saturated blue colour. One sample displayed a distinct blue colour zone, whereby all others showed a rather uniform colour distribution with common illumination. Under the microscope they showed features indicating a heat treatment. However, when examining in an immersion cell, these sapphires showed partially strange uneven colourless rims of about 1mm thickness. Surprisingly the colourless zones do not follow completely the outline of the cut stones. Similar observations had already been communicated recently by Ken Scarratt (AGTA Gemlab, New York, 18 July 2003) and created some controversy about the reason for this feature. Is it due to a diffusion process, involving chemical elements which are intruding the sapphire from outside during the heat treatment? This could have a further major negative impact on the market of corundum similar to the introduction of beryllium diffusion treated corundum in 2001 and 2002 (see *JNA*, Dec. 2002, page 74).

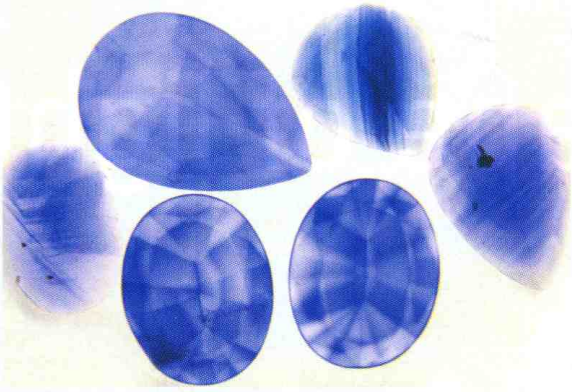

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Fig. 1 Sri Lankan heated blue sapphires with near colourless rims, a feature that has nothing to do with beryllium diffusion, but with a surface fading during the thermal treatment. Photo in dijodomethane immersion

So far no final result has been produced, whether this zoning is due to a diffusion process or not, but investigations from several gemmological laboratories are under way, using highly sophisticated analytical methods (e.g., SIMS, LA-ICP-MS). SSEF has also been asked by the National Gem & Jewellery Authority of Sri Lanka to carry out a detailed investigation on this treatment in order to help them to protect the reputation of the Sri Lankan gem industry.

Fig. 2 Sri Lankan heated blue sapphires. The larger stones were diffusion treated with Ti in 1983 and show the typical colour distribution for that treatment. The smaller stones are only heated and show natural zonation and the typical decrease of colour towards the girdle. Picture in dijodomethane immersion

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The analyses carried out at SSEF involved all classical as well as sophisticated tests. There was no foreign element found with elemental analysis (LA ICPMS). We were informed from the National Gem & Jewellery Authority of Sri Lanka that electrical furnaces with protective gas were used for the heating of the stones which proceeds usually at 1,800 °C. As known since long (see e.g. Nassau 1982) a reducing atmosphere is necessary to develop blue in Geuda sapphire. The reductive atmosphere in a furnace is provided by either burning fuel, a process that removes free oxygen. A second way to have a reductive, i.e. oxygen-free atmosphere, is to flood the furnace with a neutral gas (e.g. nitrogen). The main reason for the blue colour in Sri Lankan heated sapphires is the charge transfer band of Fe^{2+}/Ti^{4+}. In oxidising atmosphere blue colour is rather diminishing, Fe^{2+} changes to Fe^{3+} and the Fe/Ti charge transfer is destroyed. We can now imagine a similar process of oxidation at the end of the treatment of the blue sapphires with colourless rim. We think that towards the end of the heating process the pump for protective gas is stopped and some air (containing oxygen) enters the furnace. A wave of oxyda-

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ICA issues its first Lab report on new findings about heated blue sapphires

The International Colored Gemstone Association (ICA) has issued its first ICA Lab Report for 2004 informing the trade of initial findings in research of some heated blue sapphires with unusual colour distribution conducted by two leading gemmological laboratories.

The latest findings released by SSEF-Swiss Gemological Institute in Basel in Switzerland, (see report on page 88) and the Gemological Institute of America (GIA) (report on page 74) concurred that they had found no evidence of diffusion in a batch of heated blue Sri Lankan sapphires that were heat treated by the same source. This followed recent reports in the trade media, in which it was suggested that a new heating process for blue sapphire from Sri Lanka may involve "lattice diffusion."

ICA's president, Joseph M. Menzie, noted that the ICA Lab Alerts were developed to inform the trade, the international gemmological community, the media and the public at large of any developments related to the discovery, detection and identification of treatments and enhancements of natural gemstones, synthetic gemstones and gemstone simulants.

"Our first responsibility is to protect the consumer, and as such protect our product and the relationship with our buyers," he stated. "ICA has been very effective in disseminating information about treatments and leads the gemstone industry by advocating and adhering to a practical, easy-to-understand disclosure system," he noted.

"In addition, when a false alarm is raised, ICA also needs to act and inform. In this most recent case, early reports suggested that a new heating process involved diffusion. Thus far, such charges have proven unfounded, and, in fact, reasonable explanations have been put forward to explain what is being observed."

Menzie noted that the representatives of SSEF and GIA had researched stones that were heated using this particular process and both parties had come to the same conclusion that there is no evidence at this point in time that any foreign elements, which may point to diffusion, were involved. SSEF's research team even suggested that the colorless rims on the surface of the stones were caused by a technical oversight in the heating process, during which a minor degree of oxidisation occurred-causing surface decolorisation. The fact that the surfaces of the cut sapphires that were originally studied were not uniformly decolorised was because the stones had been heat treated as rough, and therefore, most of oxidised areas had been polished away.

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tion may just affect the surface and decolorise a surface related layer of the stone: colour fading occurs in the last phase of the treatment (Fig. 1).

Now at the latest it becomes clear that the disputed heat treatment must be performed on uncut stones which is mostly the case. Many rough sapphires are first heated and then cut in order to take profit from a good orientation of the shape. Should these heated rough stones produce a colourless margin, it would partly be removed during shaping and polishing. In our present case we are thus dealing with sapphires which sustain parts of surface related fading zones. Once this message will reach the Sri Lankan heaters we suspect that they may change slightly their way of operation in respect of protecting the sapphires to the very end of the treatment and avoid the de-colorisation of surface related zones.

We can make surprising observations when looking at page 68 of "SSEF Standards & Application", a reference book which was printed in 1998. We find pictures of heated sapphires taken in 1983 (Fig. 2). The three stones which were heated but not diffusion treated show a very similar colourless margin which is merging with colourless parts of the stone. It is clear, as seen with synthetic blue sapphires, that the colour gets less when it comes to the girdle area. Natural irregularities in colour distribution may interfere with this effect and create the "unusual colour distribution" (*GIA Insider*, Dec. 12, 2003, Breaking News from GIA Research). Again comparing with literature (*Gems & Gemology* Summer 1990, p. 127) we consider the effect less new and less intriguing. The "new" effect which created some uproar may be considered as a accumulation of three effects which are:

a) The colour decreases towards the girdle (thickness effect)

b) The colour may be inhomogeneous (growth effect)

c) The colour may fade along the surface (treatment effect)

In the light of the above explanation SSEF will describe stones as shown in Fig. 1 as heated when it comes to a test report. We do not see evidence of diffusion of a foreign element as in the case of the beryllium treated orange and yellow sapphires.