E2-14 Heat-treatment studies on yellow geuda (sapphires)

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The conversion of yellow geuda to yellow sapphires is an important process for Sri Lanka for value addition in the gem industry. Therefore, the understanding of the physicochemical properties of yellow sapphires has special relevance. Heat treatment of yellow geuda was done in order to develop an intense yellow coloration and to improve the clarity of samples. The development of colour is based on heat treatment of natural samples above 1600°C for several hours.

The chemical analysis of selected types of yellow geuda was carried out by the Seiko SEA 2010L energy dispersive X-ray fluorescence analyzer. Optical absorption spectra of the samples were taken from 200 to 1100nm at room temperature using a Shimadzu UV-160A/UV-visible spectrophotometer before and after heat treatments. Different heat treatments were tried under oxidizing and reducing conditions using Lakmini and electrical furnaces and their absorption spectra were re-recorded.

Natural yellow sapphires contain high amounts of Fe_2O_3 (0.1-2.0 wt%) which is the major colour producing impurity. Among the other transition metal ions Ti is the dominant element and its concentration was found to be in the range 0.01-0.1% by weight. After heat treatment, he colour and the clarity were improved by ca. 80%. The resulting yellow colours vary in intensity from very light to golden yellow or dark brownish yellow. Some turn to blue or colourless and bi-colours can also be observed. A few samples, especially those having light to dark yellow colours initially became brownish yellow after heating.

The absorption spectra of yellow geuda mainly show spin-forbidden bands with one sharp absorption maximum and 2 weak broad bands.

An appreciable increase in peak intensities of the broad bands in most of the samples has been observed after the heat treatment. The cause of the yellow colour in sapphires can be attributed to spin-forbidden single iron transitions and exchange coupled pair transitions of single or double pairs of ferric iron.

The intensity of the yellow coloration is sensitive to the oxygen in partial pressure of oxygen in the furnace. This coloration can be enhanced or reduced under appropriate heat treatment conditions.

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