

The Origin of gemstones

Gemstones are rare and they are not found everywhere on the earth, but many gemstones are found in more than two different places or countries. Origin of a gemstone tells us from which geochemical environment (country) the gem belongs to or mined out. Every gemstone has an origin in terms of geological settings and geological location. But what difference does it make if we have ruby or sapphire from different countries?. More often than not the customers look for gemstones of a particular origin. For example Kashmir sapphires, Burmese Rubies and Columbian emeralds carry a Historical image ; their distinctive locations and their overall beauty primarily based on their colour and their unique qualities reflect in the price tag that they carry along with them. From trade point of view, origin certificate is very important. Unlike earlier days, with evolution of sophisticated analytical spectroscopic techniques, identification of origin of a gemstone is more of science rather than an art from an experienced gemmologist. It is combination of reliable scientific measurements on elemental analysis and microscope based observations on inclusions and patterns by an experienced gemmologist. Methods for Identifying the origin of gemstones thus consists of two parts, identification characteristic inclusions and instrumental methods of analysis.

Gemstones of same species looks very similar and therefore the origin determination is a challenging task for Gemologist due to overlapping of characteristics inclusion that are used by Gemologist as reference. It is possible that in some cases, samples from different locations can have similar inclusions in gemstones like Rubies, Sapphires and Emeralds. Gemstones from new mines might be very similar to those from well known localities. It is very difficult to identify the origin by naked eyes. In many cases, even experienced gem experts found it difficult to identify the gemstone origin by microscope. Therefore a systematic and combined approach is needed for determination of the origin, and still in some cases it may become an opinion only.

Characteristic inclusions:

Origin determination of gemstones was started by Father of Gemmology Dr. Edward Gübelin by studying different internal features of the gemstones under microscope. He found some species have characteristic inclusions which were not found in similiar species of different origin. Burma rubies show short & stubby iridescent rutile needles and some calcite crystals. Colombian emerald has three phase jagged inclusions. Discovery of new mines in the late nineties of the last century not only created good supply of Rubies, Sapphires and Emeralds but also made origin determination a challenging job for gemmologists around the globe. Flawless (lack of inclusions) gemstones from new and old mines made it difficult for the traditional gemmologist to ascertain the origin of gemstones.

Instrumental methods for analysis:

It is common sense that testing techniques of precious gemstones should be non destructive. There are many analytical techniques to find out the elemental composition of the gemstone. Energy dispersive X ray fluorescence (EDXRF) is the most widely used analytical technique as it doesn't require sample preparation and it is relatively cheaper compared to other elemental analysis techniques. The limitations of EDXRF technique are detection of elements ranges only from Na to U and low Z elements can not be detected. Added to that limit of detection is poor. Still it is widely used in combination with other spectroscopic techniques to determine the origin of gemstones.

Other analytical techniques like Secondary Ion Mass Spectrometry (SIMS) and Laser Ablated – Inductively Coupled Mass Spectrometry (LA- ICP-MS) are used for low Z elements detection and measurement with superior limit of detection as low as a few ppb to 1 ppm . Only limitation is that the ablation efficiency varies from element to element. ED XRF is superior in that it will give relative elemental ratios whereas an expensive LA-ICPMS is useful to identify the presence of sub-trace level elements.

Rubies are composed of mainly Al_2O_3 with some percent of chromium for its red colour. Rubies from all origins will have similar major composition of Aluminium and Oxygen with minor impurity of chromium. During the formation of gemstones, geochemical conditions play an important role which result in the addition of trace amount of impurities which holds the key for identification of the geographical origins. e.g. low amount of Fe and presence of Vanadium can narrow down origin to marble hosted rubies from Burma. Similarly low concentration of Fe and high concentration of Vanadium points toward Colombian Emerald.

GII is equipped with most of the sophisticated analytical solid state spectroscopic equipment to determine the origin of gemstones like rubies, sapphire and emeralds. GII has its own method of identification of the species with the help of spectroscopic data in combination with the traditional gemmological observations on inclusions patterns.



Short Stubby Rutile Needles from Burma. (Ref.1)



Three phase jagged inclusions in Colombian Emerald. (Ref 2)

Ref. 1 lotus.gemmology.com/inclusions_gallery

2. Ruby-sapphire.com

3. Michael S. Krzemnicki et al, Origin Determination of Gemstones: Challenges and Perspectives, Proc. of the 1st GIT International Gem & Jewelry Conference (GIT 2006), Thailand

4. Abduriyim A. and Kitawaki H, Applications of Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS) to Gemmology. Gems & Gemology, 42 (2006) 98-118