Perspectives of LIBS in gemstone testing
Analysis of light elements such as beryllium, boron, lithium

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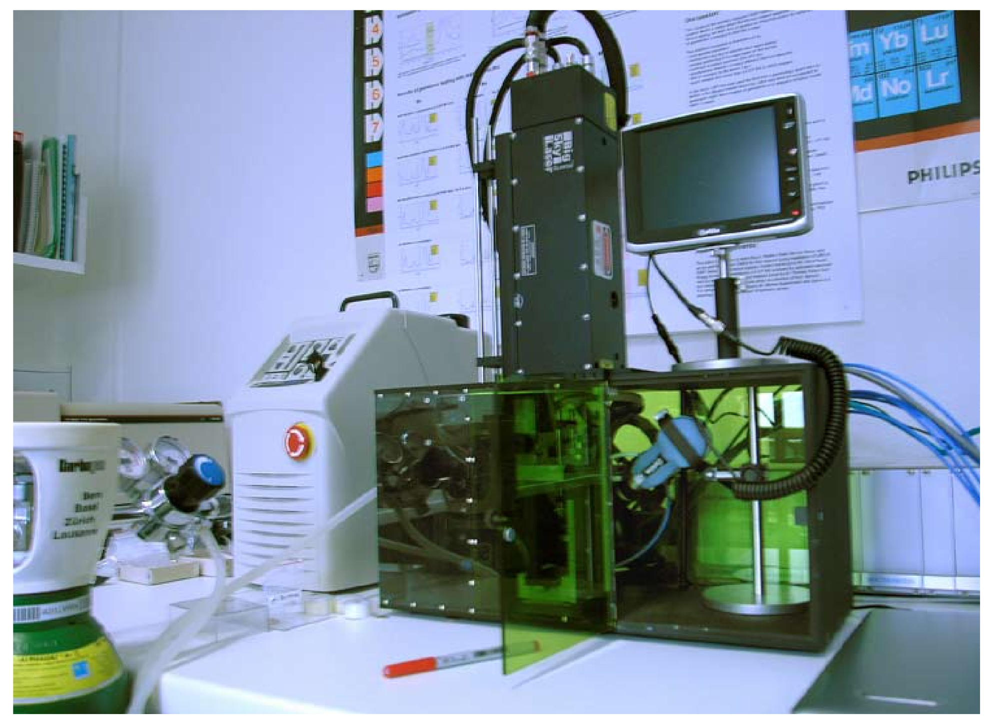
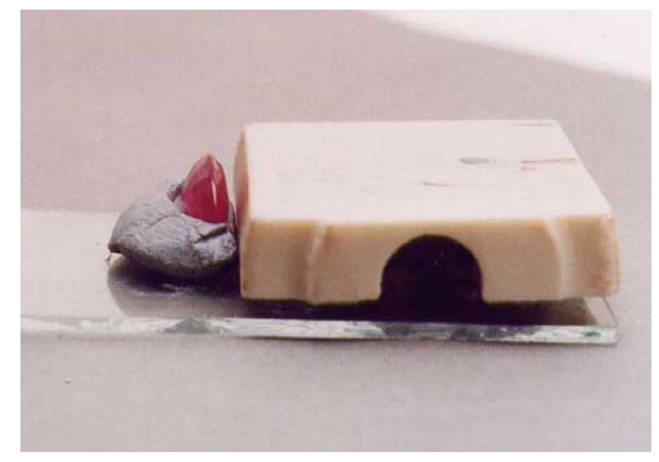
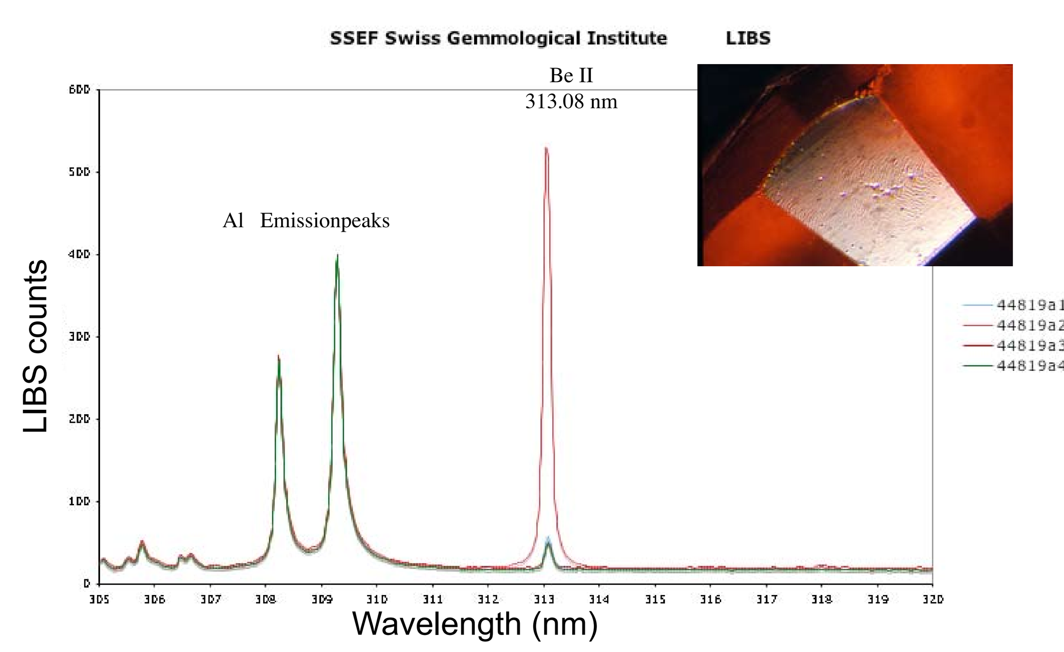
Laser induced breakdown spectroscopy (LIBS) has been developed in the 80ies as a fast and reliable method for chemical analysis and has been used in a wide range of applications in industry and environmental sciences ever since. Only recently, LIBS has been applied to gemstone testing (Hänni et al. 2004, Krzemnicki et al. 2004) where it proved to be very successful for the detection of beryllium diffusion treated corundum. With LIBS, we were able to detect beryllium in corundum down to 2 ppm. Diffusion treated corundum generally reveal concentrations of > 5 ppm beryllium, whereas untreated corundum shows no or only low ppb concentrations of Be. All samples are flushed with argon gas, by which the peak/background ratio is generally improved by a factor of approx. 4 compared to the analysis in atmosphere. Based on our experience, LIBS has shown to be a reliable and fast method for detection of this treatment. Since its first introduction at SSEF in early 2004, it has now been installed in several other gemmological laboratories worldwide as a rather low cost possibility for beryllium detection in gemstones.



SSEF GemLIBS consist of a pulsed Q-switched Nd-YAG laser at at 266 nm with a series of seven high-resolution spectrometers (Ocean Optics LIBS 2000+) to collect emission from 200 to 970 nm.



To minimize any damage, the stones are tested on the girdle.

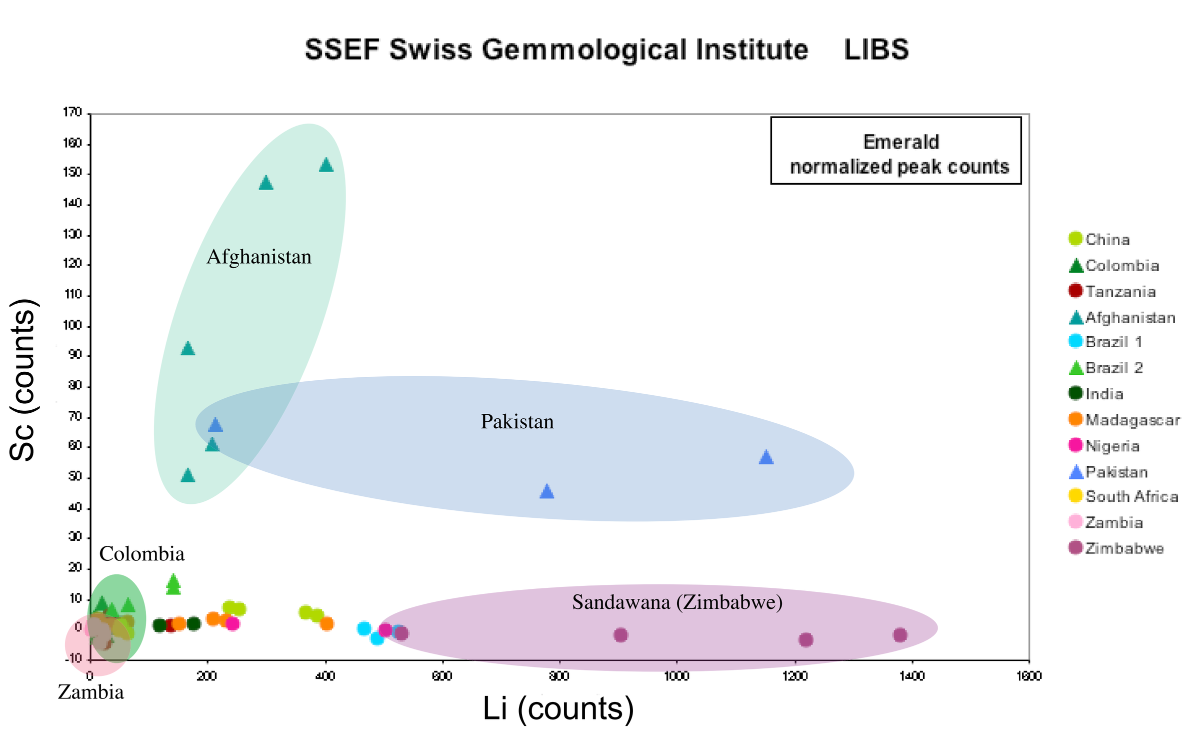


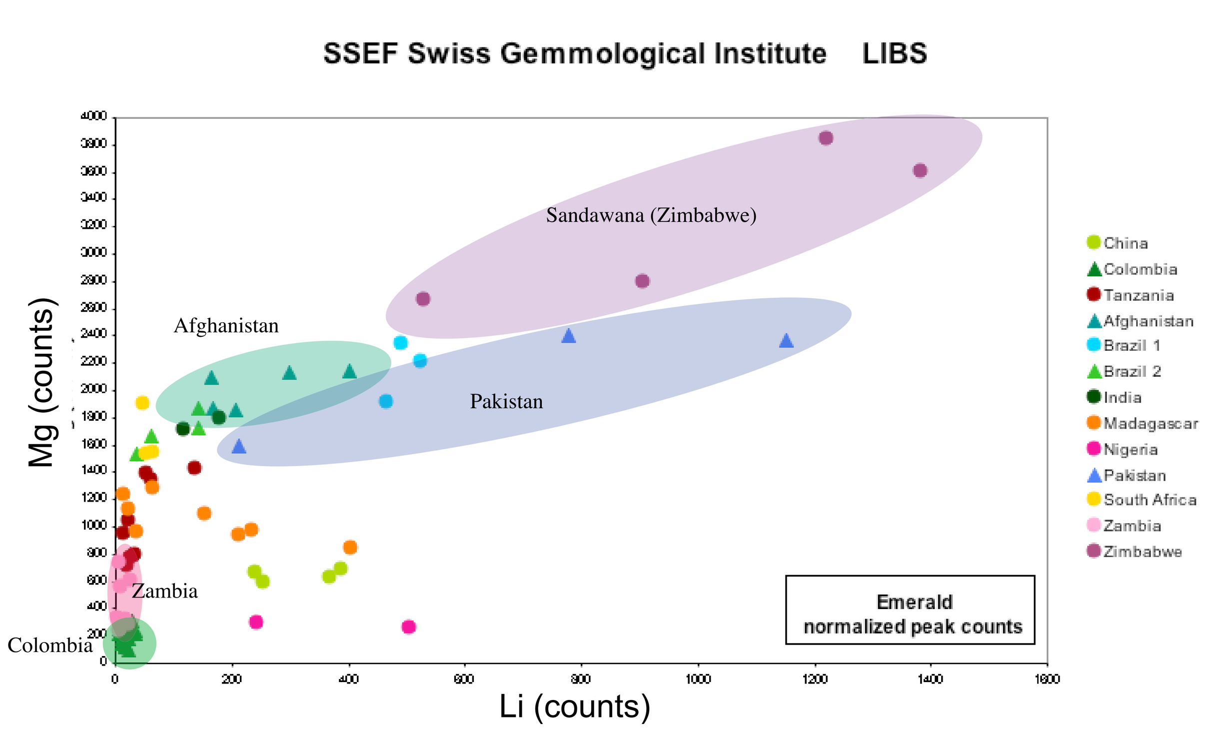
Beryllium detection in corundum is based on the 313.08 nm emission. The red spectrum represents the beryllium-rich glassy residue on the surface of a Be-diffusion treated ruby.

Emeralds from different origins, analysed by LIBS

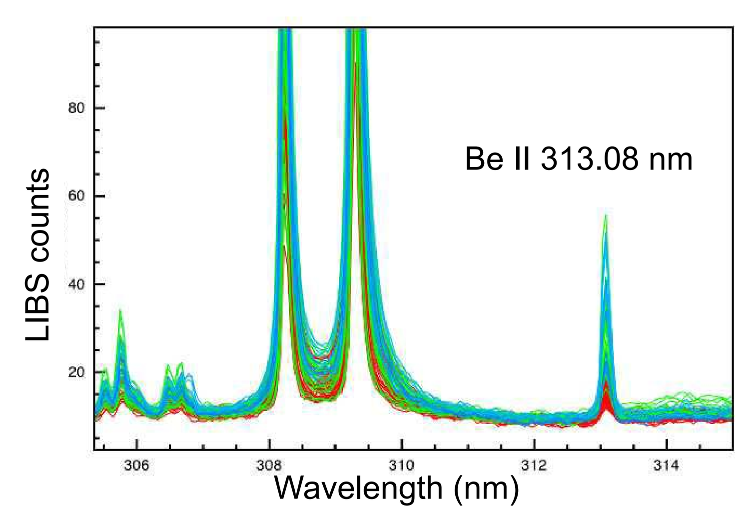
Diagrams below show normalized LIBS netto peak counts for emeralds from different origins:
- lithium versus scandium
- lithium versus magnesium

Each data point represents the average of 20 laser analyses on one sample.

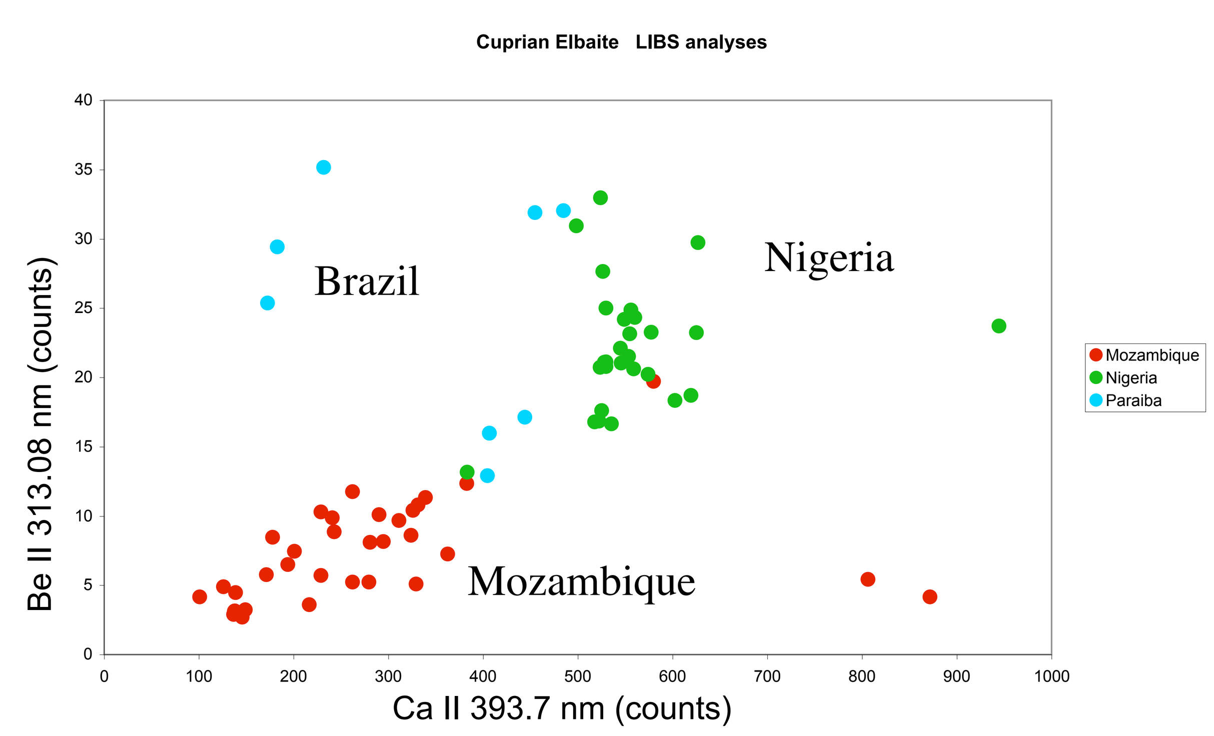




Light elements such as boron, lithium, and beryllium and even Na and Mg at low ppm levels were so far not easy to measure. As the light elements may play an important role in treatment detection and in origin determination of gemstones, we have analysed various gemstones with LIBS for these light elements. Characteristic emission signals of boron (249.8 nm, 317.9 nm), beryllium (doublet at 313.1 nm) and lithium (670,7 nm) have been analysed on a number of gemstones such as corundum, beryl, pezzottaite, tourmaline, chrysoberyl, and opal.



Beryllium peak at 313.08 nm analysed with LIBS in copper-bearing tourmalines from Brazil (Paraiba), Nigeria, and Mozambique.



The diagram shows Be versus Ca (normalized netto peak counts) of these tourmalines.
Each data point represents the average of 20 laser analyses on one sample.

Copper bearing elbaite tourmalines from Mozambique, analysed by SSEF.