



## Gem-quality topazes with different origin: Can LIBS help us identify their occurrence?

G. Tempesta <sup>1</sup>, G.E. Elettivo <sup>2</sup>, G. Agrosi <sup>1</sup>

<sup>1</sup> Dipartimento di Scienza della Terra e Geoambientali, Bari (Ba), Italy

<sup>2</sup> Affiliazione 2

Indirizzo e-mail dell'autore che presenta: [gioacchino.tempesta@uniba.it](mailto:gioacchino.tempesta@uniba.it)

Topaz is an orthorhombic nesosilicate with the formula  $\text{Al}_2\text{SiO}_4(\text{F}, \text{OH})_2$ . Its physical properties, such as colour, hardness, transparency, and refractive index, and its great accessibility make this mineral widely used in jewelry. In nature, topaz can be found in different colours and various intensities of yellow, brown, blue, pink, and red, although the most common variety is colourless topaz. In the gemological field, the most requested colour is blue, a rare colour in nature, which, however, can be obtained with different intensity and saturation through irradiation treatments even from originally colourless material. The colour topaz is linked to point defects such as substitutional atoms like Na, Ca, Fe Cr, V, Ti, B (Gatta et al., 2006), impurities, and/or structural defects. The different types of trace elements and their quantity, often present in the structure of topaz, are closely linked to the formation environment. Laser-induced breakdown spectroscopy (LIBS), a technique that allows the elemental analysis in a single shot of major, minor, and trace elements, is therefore suitable for evaluating the compositional differences of topaz (Abbasi et al., 2021). Although the technique is partially invasive, its use, coupled with a microscope, allows the size of the ablated material to be made almost invisible (a few microns) and, therefore, suitable for samples to be used as gems. In this study, gem-quality samples from different countries and deposits were analysed by micro-LIBS. Colourless or very light blue samples from Brazil, Madagascar, Mozambique, Nigeria, and Tanzania were analysed, as well as pink, yellow, and yellow-orange samples from Brazil, Utah (USA), Nigeria, and Zambia. LIBS analyses on topaz allowed the identification of the main emission lines of many elements: in addition to the major ones (Al and Si), Li, B, Na, Cl, Mg, K, Ca, Ti, V, Cr, Mn, Fe, and Ni were identified. F and OH could not be identified due to the existing setup. From an initial comparison of the data obtained, it was noted that the presence of some light elements, such as Li and B, present in traces is particularly linked to some deposits (Hervig et al., 1987). The results obtained demonstrate that this study can be considered a pilot study in which LIBS plays a primary role in the qualitative and quantitative analyses of precious stones, analyses useful above all for identifying the provenance of the gems.

Keywords: topaz, provenance, LIBS, trace elements, light elements.

### References:

- Abbasi, S.A.; Rafique, M.; Khan, T.M.; Khan, A.; Ahmad, N.; Faruque, M.R.I.; Khandaker, M.U.; Ahmad, P.; Saboor, A., (2021): *Minerals*, **11**, 367.
- Gatta, G. D., Nestola, F., Bromiley, G. D. and Loose, A., (2006): *American Mineralogist*, **91**, 1839-1846.
- Hervig R.L., Kortemeier W.T., Bur D.M., (1987): *American Mineralogist*, **72** (3-4): 392-396.
- Rossi, M., Dell'Aglia, M., Giacomo, A., Gaudiuso, R., Senesi, G.S., Pascale, O., Capitelli, F., Nestola, F. and Ghiara, M.R. (2014): *Phys Chem Minerals*, **41**, 127-140.