Thermal Effect on The Cathodo- and Thermoluminescence Emission of Natural Topaz ($Al_2SiO_4(F,OH)_2$). Correcher, V.[1] , Garcia-Guinea, J[2], Martin-Fernandez, C[2]., Can, N[3]. [1]CIEMAT. Av. Complutense 22. Madrid 28040, Spain. [2]Departamento de Geologia y Geoquimica. Museo Nacional Ciencias Naturales. CSIC. 28006 Madrid. Spain. [3]Celal Bayar University, Faculty of Arts and Sciences, Physics Department, 35040 Manisa-Turkey. Correspondence author: v.correcher@ciemat.es

Introduction. Most of gemstones, being natural materials (silicates, carbonates, phosphates, etc.), exhibit luminescence emission. Such property is of great interest since could be potentially employed, not only for dating purposes, but also as personal dosimeters in case of radiation accident or radiological terrorism where conventional monitoring was not established. For these purposes the laboratory routine is mainly based on the analysis of the blue emission (at about 400 nm) of natural materials. This emission, that is strongly dependent of the temperature, is produced by the incidence of the radiation on the aluminosilicates lattices that induces mobility of the alkalis causing a high number of electron–hole pairs in the lattice. Alkali self-diffusion through bulk and interfaces gives rise to a continuous alkali–oxygen bond splitting–linking processes with continuous formation–destruction of $[AlO_4]^o$ centres. Some holes can be trapped, forming $[AlO_4/M^+]$ centres. When the supplied energy is enough, the recombination of the electrons with the hole trapped adjacent to $Al\text{-}M^+$ reduces the presence of ionic charge compensators at the Al sites and induces the blue luminescence emission to $[AlO4]^o$ centres (aluminium–hole centres). In this sense, this paper reports about the influence of the temperature on the thermoluminescence (TL) and cathodoluminescence (CL) behaviour of a well-characterised topaz from Badajoz (Spain). TL provides information about the trapped charge recombination sites related to metastable defects inside the lattice depending on whether the detrapping process is due to heat. CL is a process whereby light is created from an energetic electron beam. CL supplies data about transient defects after irradiation on the surface of the lattice. CL is used in the identification of the migration and diffusion of some luminescent centres from the emission bands.

Results. The CL spectra all clearly show two features viz., a shoulder emission band at near 340 nm (3.64 eV) and a sharp emission at 450 nm (2.75 eV). Since the excitation efficiency of CL is not uniform with depth one possibility is that the defect centre which is responsible for this particular emission, could be present closer the surface. For the low temperature CL measurements the 450 nm emission disappeared but the 340 nm emission becomes sharper. In addition to these features, another broad band is featured between 650 nm (1.91 eV) and 750 nm (1.65 eV). Comparison of signals with other silicates may be helpful and these features are similar to those observed in thermally treated quartz where they have been attributed to $(AlO_4)^o$ and $(H_3O_4)^o$ centres.

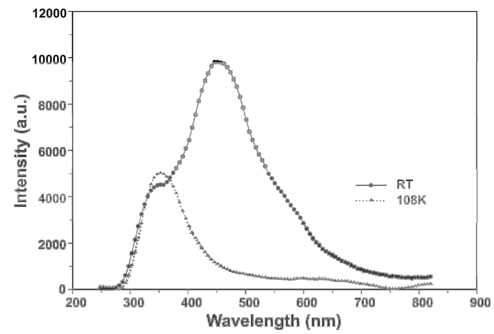

Fig 1. CL of natural topaz taken at room temperature and low temperature

TL glow curves of different aliquots of natural topaz are shown after the preannealing treatment. In the whole natural TL glow curve a broad peak is appreciated at 240°C followed by a second structure consisting on a wide broad distribution peaked at 450°C. In the whole curve the TL features typically involve a gradual and progressively shift of the maximum peak up to higher temperatures and a change in the shape and intensity of the TL distribution in accordance with the thermal pre-treatment. The thermolabile broad band of blue emissions shows TL glow curves of multi-order kinetics involving continuous processes of trapping-detrapping. These thermal phenomena of TL could be involved in consecutive breaking and linking of bonds of Al-O, Si-O, redox reactions and also losses of fluoride ions.

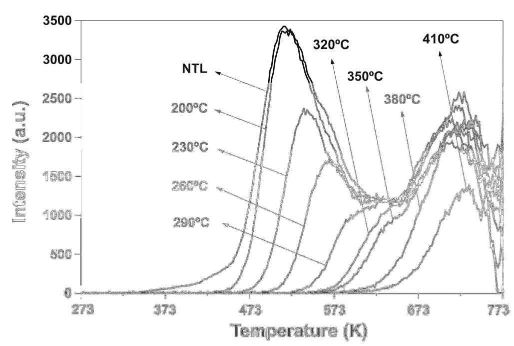

Fig 2. TL glow curves taken after preheating with temperatures from 200 to 410°C.