
Ancient TL

www.ancienttl.org · ISSN: 2693-0935

Short, M. and Huntley, D., 1992. *Infrared stimulation of quartz*. Ancient TL 10(2): 19-21.
<https://doi.org/10.26034/la.atl.1992.195>

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Infrared stimulation of quartz

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The ability of infrared light to stimulate luminescence from old natural quartz was reported by Godfrey-Smith et al (1988). More recently the Oxford group have reported otherwise and have been using the lack of any infrared response as an indication of the success of their quartz separation procedure (see for example Spooner and Questiaux, 1989; Smith et al, 1990). This note describes the result of an experiment attempted in order to address these differing observations.

Obvious explanations of the discrepancy are (a) that it is simply a matter of intensity and sample sensitivity, and (b) that the quartz for which the phenomenon was observed was not pure either due to inclusions within the quartz grains of, for example, feldspars, or due to an unsuccessful separation. One method of testing these ideas is to measure the spectrum of the luminescence emitted under infrared stimulation. If a contaminant is the cause then likely candidates are K-feldspars which, Hütt et al (1988) showed, have a remarkably high sensitivity to infrared stimulation. The emission spectra of these is primarily a band at 400 nm while plagioclase feldspars show predominantly a band at 570 nm (Huntley et al, 1991). Zircons, which are also 'bright' have bands at 485 and 580 nm (Godfrey-Smith et al, 1989). The only quartz for which an emission spectrum is available so far, and which is the quartz on which the present experiments are done, shows a band at 365 nm (Huntley et al, 1991). There is then the possibility for the luminescence spectrum to give some indication of the mineral responsible.

The sample for which the results of measurements are reported here is quartz separated from the East Naracoorte dune in southeast South Australia. It is about 800,000 years old (Idnurm and Cook, 1980). The material is calcarenite, for this sample being about 81% CaCO₃ and 16% quartz with minor amounts of feldspars and heavy minerals; the potassium content is 0.2%. 100 µm grains were separated using HCl, sieving, HF, magnetic separation, and density separation using sodium polytungstate. X-ray powder diffraction showed only lines attributed to α-quartz. Infrared irradiations were performed using an array of 16 Telefunken model TSUS-5402 diodes (950 nm emission) mounted in a ring over a TL oven similar to the arrangement described by Poolton and Bailiff (1989). The spectra were determined by successively placing different Schott

longpass filters between the sample and photomultiplier tube (equipped with a KG-1 and two BG-38 filters to absorb scattered IR from the diodes), and using the measured luminescence intensity differences to calculate the emission intensity at the appropriate wavelength. This procedure is described in detail in Jungner & Huntley (1991). (In our case there were no mirrors of unknown reflectivities). There was about 2% draining of the sample by each IR exposure (5 s at 10 mW/cm²) and this was corrected for. In addition, two samples were measured, one from short to long wavelengths and the other in the reverse direction, as a check.

The results obtained from these two samples are the curves shown in figure 1a. There is good agreement between the different results except at the short wavelength end. The differences here could be due to a change in spectrum with draining, or just scatter in the data; more measurements would be required to clear this up. In order to test whether or not the spectrum altered as a result of trap draining one of the samples was measured again after an additional IR exposure of 25 mW/cm² for 100 s. This was measured using 25 mW/cm² and the result is the lower curve in the same figure; there is some evidence of a change.

It is apparent that the dominant emission from the sample is in the 300-450 nm range and that there is relatively little emission between 450 and 600 nm, above which the BG-38 filters are non-transmitting. The emission spectrum of the same quartz under 647 nm stimulation is shown in figure 1b; this is quite different. Also very different are plagioclase and zircon spectra (Huntley et al, 1989, Godfrey-Smith et al, 1989).

The emission at wavelengths greater than 400 nm appears similar to that of the 400 nm band observed in K-feldspars, an example of which is shown in figure 1b. Explanation of the emission from 330-380 nm is more difficult. While some of this could be due to the quartz we note that Bailiff and Poolton (1991) have shown that feldspars exhibit a variety of different spectra in this region; their spectrum for an albite comes closest to the present spectrum and is shown in figure 1b also.

While we cannot make any definite conclusions it does seem likely that the emission is not from the quartz itself and that possible candidates are feldspar inclusions

in the quartz grains. Such inclusions have been observed by Spooner (1987, p.87) in similar quartz grains from the Woakwine Range. We must note, however, that the current information on spectra is limited and that we cannot rule out the possibility that the emission is indeed from the quartz, or from some other mineral as yet unidentified.

Acknowledgements

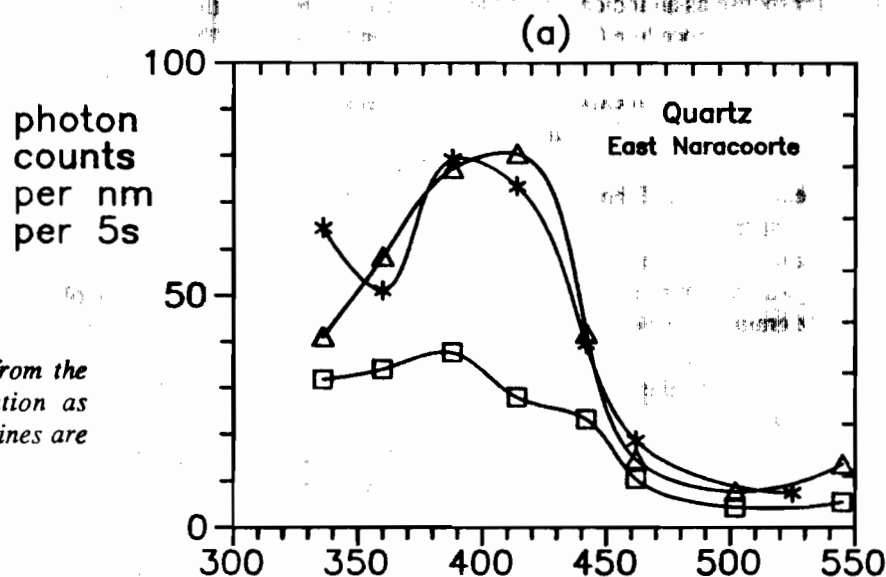
We thank J.R.Prescott and J.T.Hutton for assistance with the sample collection, O. Lian for preparing the

quartz grains, and K. Dunphy for XRD.

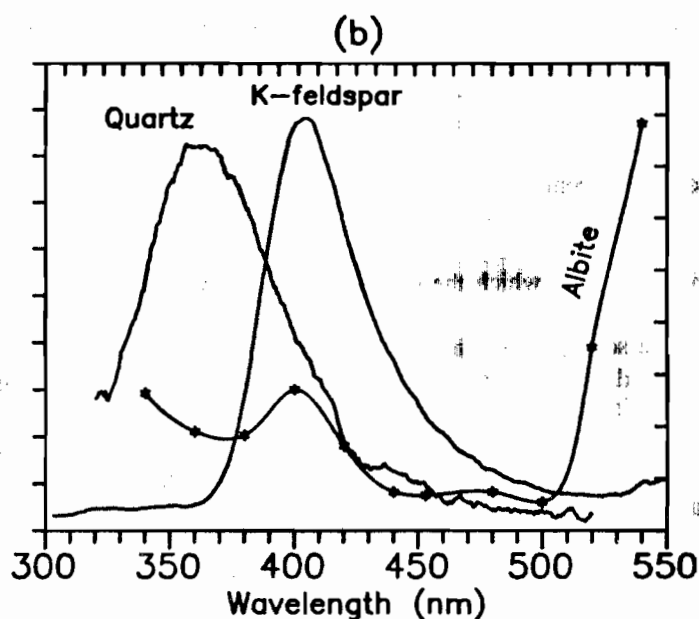
This work constitutes part of the M. Phil. Studies of M.A.S. who would like to acknowledge Dr. M.Y. Tso, Director, Radioisotope Unit, University of Hong Kong, for her support, and Mark Readhead for useful comments. Financial support by the Natural Sciences and Engineering Research Council of Canada is gratefully acknowledged.

Figure 1.

(a) Emission spectra obtained from the quartz under 950 nm stimulation as described in the text. The solid lines are cubic spline fits through the data.



(b) Emission from the same quartz under 647 nm stimulation and K-feldspar under IR stimulation (Huntley et al, 1991), and an albite under IR stimulation (Bailliff and Poolton, 1991).



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