DDR-P-09
Cw-Osl And Plm-Osl Properties Of Natural Quartz Crystals.

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In this project four varieties of quartz crystals (Q1, Q2, Q3 and Q4), with different colors, were investigated by Instrumental Neutron Activation Analysis (INAA) to determine the major, minor and trace elements and luminescence response by CW-OSL and PLM-OSL. The investigation was focused on the role of the impurities in the luminescence emission.

Gama spectroscopy were carried out in all four quartz crystals using a Ge-hyperpure detector, model GX 1925, from Canberra. The spectra were collected by Canberra S-100 MCA with 8192 channels. The samples were irradiated at research reactor IEA-R1 (IPEN-CNEN/SP) with thermal neutron flux $1{,}2 \times 10^{12}$ $n.cm^{-2}.s^{-1}$ for 8 h. INAA results showed that quartz Q1 has the following elements which can be related to luminescence emission in ppm, except if indicated: Lu (0.63±0.16), Yb (2.33±0.75), La (8.31±0.29), Cr (1124±45), Fe% (0.215±0.001), Eu (0.39±0.04), Ce (36.4±0.2) and Co (50.15±0.07). For Q2 elements with long and middle half life were not detected with this specific experimental methodology, therefore Q2 is almost pure quartz without any impurities. In the case of Q3 only Cr (4.13±0.02) could be determined. Finally, for quartz Q4 were found Lu (0.12±0.05), Yb (0.77±0.47), La (7.85±4.40), Fe% (0.125±0.007), Eu (0.35±0.06) and Ce (0.81±2.60).

OSL measurements were performed using a RISØ TL/OSL reader (model TL/OSL-DA-20).

CW-OSL indicated that Q1 has predominant fast component and higher luminescence response, followed by Q2 and Q3, and Q4 has lowest one. All the OSL emission increased with β irradiation. After thermal treatment (500°C during 12 minutes) OSL response changed, Q1 and Q3 supplied more constant behavior, however Q2 and Q4 have an increase in the OSL response. Due to the observed changes, CW-OSL curves were deconvoluted using first order equation [1]. Table shows decay rates of individual components obtained after two different thermal treatments. The decay values are similar to those found by Polymeris *et al*, 2009 [2] for natural milky quartz, excepting to t_1, which was about 20 s; it can be note that the present OSL measurements were made at 120°C, which could be influenced in these values.
PLM-OSL were obtained transforming CW-OSL curve using a variable "u" [1].

Quartz	t_1 (s)	t_2	t_3 (s)
Q1 (500°C - 12´)	0.5	165	225
Q1 (500°C - 24´)	0.5	250	500
Q2 (500°C - 12´)	1.5	350	360
Q2 (500°C - 24´)	1.1	130	200
Q3 (500°C - 12´)	0.3	65	400
Q3 (500°C - 24´)	0.3	70	300
Q4 (500°C - 12´)	0.6	250	300
Q4 (500°C - 24´)	0.4	150	230

PLM-OSL results showed that Q1 and Q3 have predominant fast component, in addition, Q3 has high medium component too. Q2 has fast, medium and slow component with intensity similar to Q1; Q4 has main medium component and lowest intensity.

The present study reveals that OSL response depends on quartz varieties and change with thermal treatments. From INAA results Q1 has many rare earth elements (REE) in the crystalline net which can be responsible for its high OSL luminescence.

1 SINGH, A.K. et al. TL-OSL correlation studies of $LiMgPO_4$:Tb,B dosimetric phosphor. **Nuclear Instruments and Methods in Physics Research**, B 274, p. 177-181, 2012.
2 Polymeris, G.S. et al. The TL and room temperature OSL properties of the glow peak at 110°C in natural milky quartz: A case study. **Radiation Measurements**, v. 44, p. 23-31, 2009.

DDR-P-10
Violet stimulated luminescence dating of Chinese loess up to ~600 ka

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Optically Stimulated Luminescence dating (OSL) of quartz and/or feldspar is arguably the most broadly applicable chronometer in Quaternary research. However, inherent saturation phenomena typically restrict reliable dating to the last 100-200 ka for quartz [1,2], and 300-600 ka for feldspar [3,4], thus leaving the majority of the Quaternary timescale (2.6 Ma) uncovered. A major developmental pathway of extending the quartz OSL dating range is Violet Stimulated Luminescence (VSL), utilising an energetic 405-nm stimulation source. Such obtained signals are characterised by a tenfold saturation limit compared to OSL, demonstrable thermal stability, and broad agreement with independent OSL ages on the <0.3 Ma timescale [6], but have not been successfully tested beyond 0.3 Ma, which is the objective of the present study.

The dose response of both the natural and the laboratory-regenerated VSL was studied on 24 quartz samples from the Luochuan section (Chinese loess plateau), with independetly constrained depositional ages in the 11-2500 ka range (Ding et al., 2002). Two different methods are tested, the single aliquot regenerative dose (SAR) and the multiple-aliquot additive-dose (MAAD) protocols; the latter constructed by incrementally adding dose to the youngest available sample.

The natural dose response curve of VSL shows a clear correlation between the luminescence signal and log(dose), exhibiting growth up to ~1800 Gy. The natural and SAR dose response curves do not overlap, implying large underestimations in equivalent doses. This likely originates in differences between the natural and the regenerated signals, caused by (i) decay curve shape change, and (ii) trapping sensitivity change after the first SAR cycle preheat. On the contrary, the MAAD and natural dose response curves do overlap, circumventing the trapping sensitivity change, and exhibiting comparable natural and added-dose decay curves. The MAAD protocol yields VSL ages in agreement with independent constraints until ~600 ka (15 samples), beyond which the natural signal becomes indistinguishable from saturation and should not be used for dating (see figure).

The range of MAAD-VSL applicability (200-1800 Gy) demonstrates a maximum limit of VSL dating of ~600 ka at Luochuan, and further implies that for typical environmental dose rates, sediments at other locations could be dated up to ~1 Ma back in time, offering a significant advance over existing methods.

[1] Wintle, A.G., Murray, A.S., 2006. Radiat. Meas. 41, 369-391.
[2] Preusser et al., 2009. Earth Sci. Rev. 97, 184-214.
[3] Buylaert, J.P. et al., 2012. Boreas 41, 435-451.
[4] Li, B., Li, S.-H., 2012. Quat. Geochron. 10, 24-31.
[5] Jain, M., 2009. Radiat. Meas. 44, 445-452.
[6] Ankjærgaard, C. et al., 2013. Quat. Geochron. 18, 99-109.
[7] Ankjærgaard, C. et al., 2015. Radiat. Meas. 81, 78-84.