

Investigating the possibility of age assessment using pigments and dyes; Preliminary luminescence and UV-VIS measurements



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Introduction

Direct and absolute dating of paintings becomes an important task which is related not only to archaeometry, but to authenticity testing also. As the main constituent of a typical painting stratigraphy, the painting layer(s) include mostly pigments and dyes. Even though the plaster layer could be a very helpful tool for indirect dating, recently specific plaster materials have been reported as very promising towards direct dating by luminescence techniques. The present study presents preliminary thermoluminescence (TL) and optically stimulated luminescence (OSL/IRSL respectively) measurements on pigments and dyes, traditionally used for paintings since antiquity.

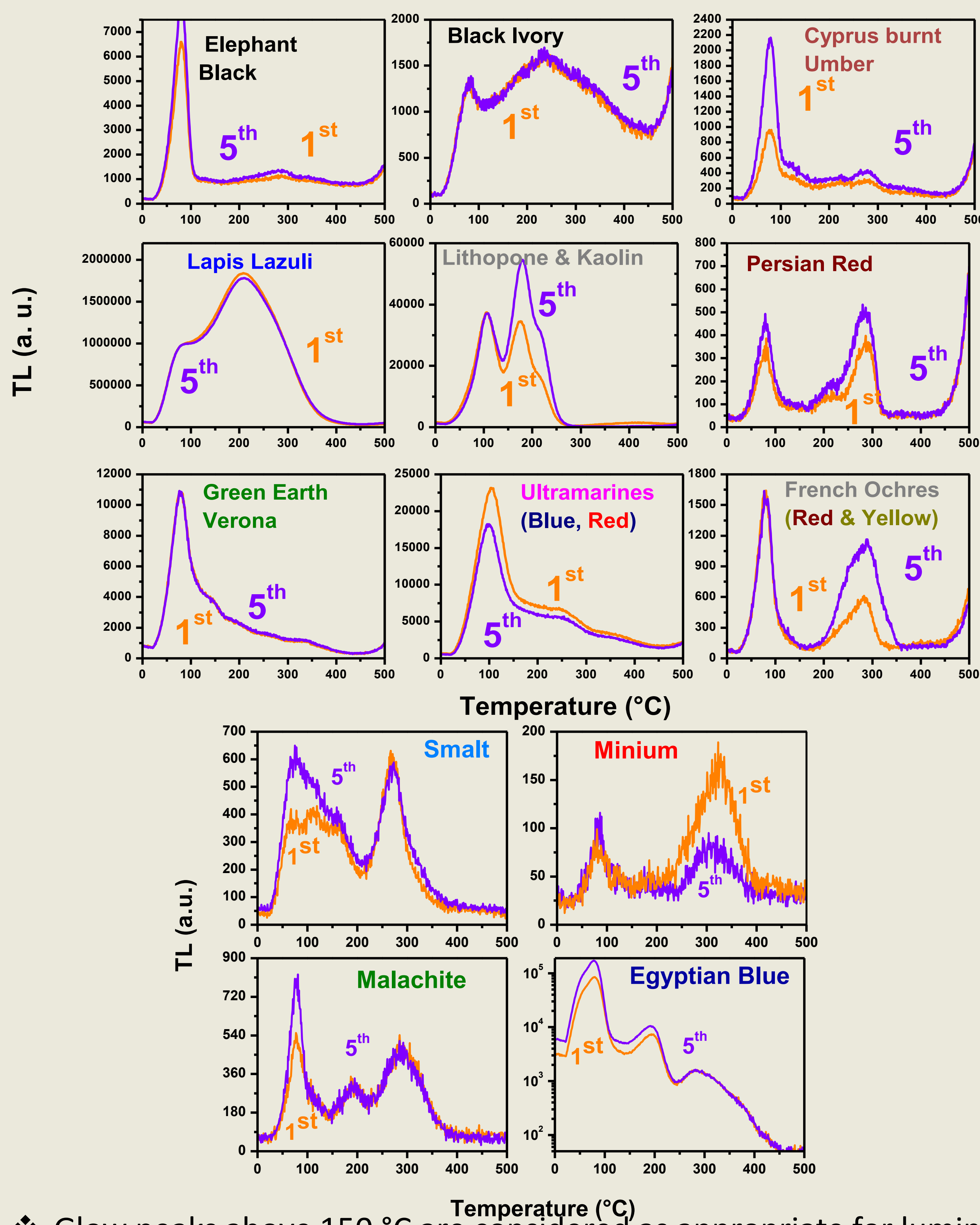
Materials and Methods

Over thirty different pigments and dyes were studied; the majority of these were of inorganic nature, consisting of silicates, aluminosilicates and inorganic carbonate content.

- ❖ Luminescence Measurements: Risø TL/OSL-DA-20 reader equipped with an EMI 9635 QA photomultiplier tube, $^{90}\text{Sr}/^{90}\text{Y}$ source at 0.110 ± 0.003 Gy/s, 7.5-mm Hoya U-340 filter. Heating was performed in nitrogen atmosphere, using a low heating rate of 1°C/s with maximum temperature at 500°C , test dose 50 Gy.
- ❖ UV-Vis Spectrophotometry: PERKIN ELMER Lambda 18 spectrophotometer, in reflectance mode with an integrating sphere, in the spectral area of 200-850 nm, with 4 scans and a resolution of 1 nm.

Results and Discussion

Thermoluminescence



- ❖ Glow peaks above 150°C are considered as appropriate for luminescence dating
- ❖ Glow peaks below 150°C , corresponding to shallow TL traps can not be used for dating purposes, unless sensitization occurs.
- ❖ Lapis Lazuli and ultramarines: Signal that originates from natural or artificial lazurite
- ❖ French Ochres indicate TL glow curves originating from quartz, being the most abundant constituent.
- ❖ Blue and white pigments are more promising for dating applications.

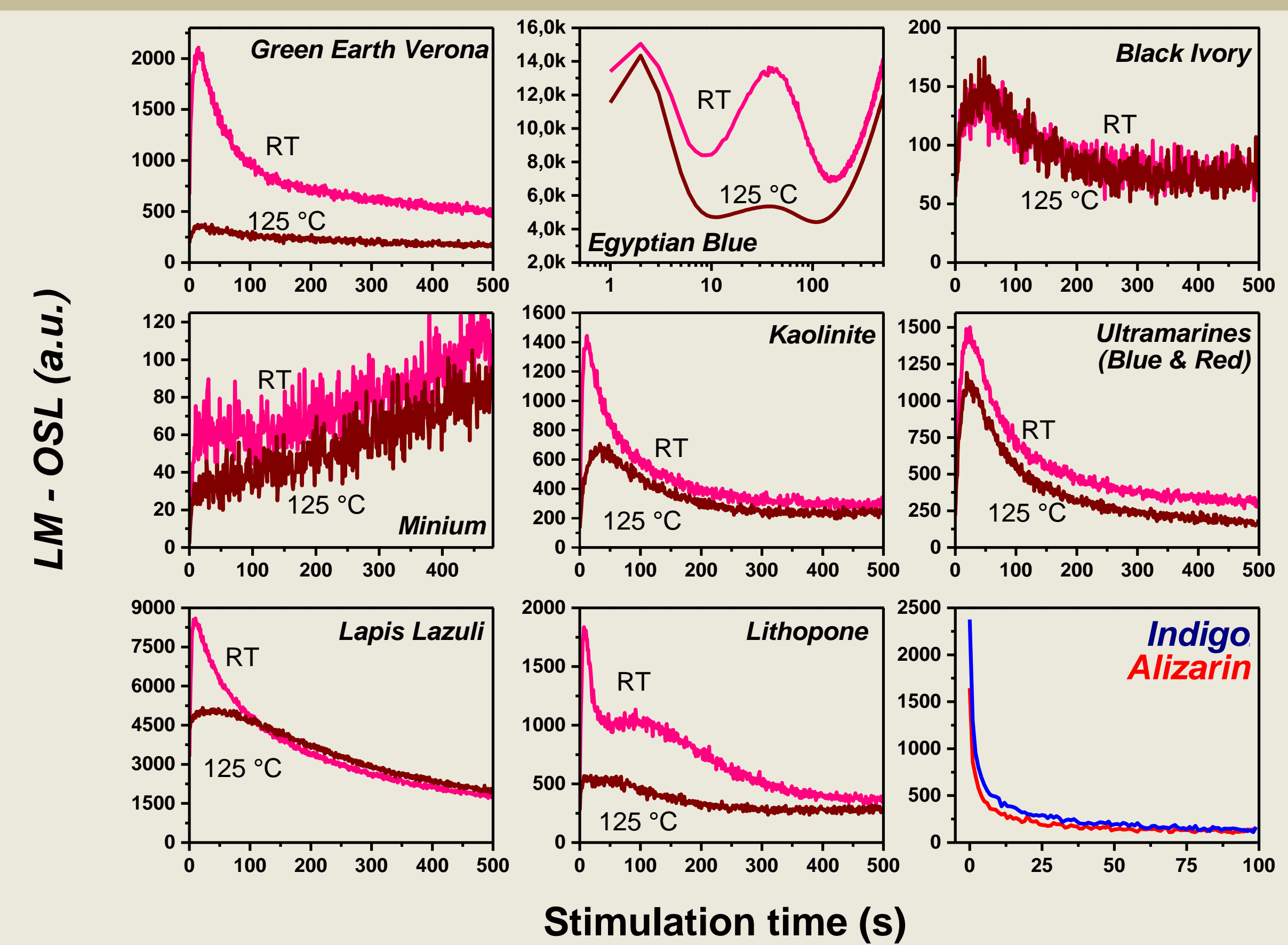
Conclusions

Preliminary measurements of pigments regarding basic thermally & optically stimulated luminescence (TL & OSL) properties were obtained, including luminescence features, such as sensitivity, glow curve shape, sensitization after repeated cycles including irradiation and measurement, bleaching ability and thermal stability, for both cases of TL as well as OSL. Dyes which lack of a indirect band gap, such as minium, both burnt and raw umber, raw Sienna and bone Black, do not yield promising luminescence features towards luminescence dating applications.

References

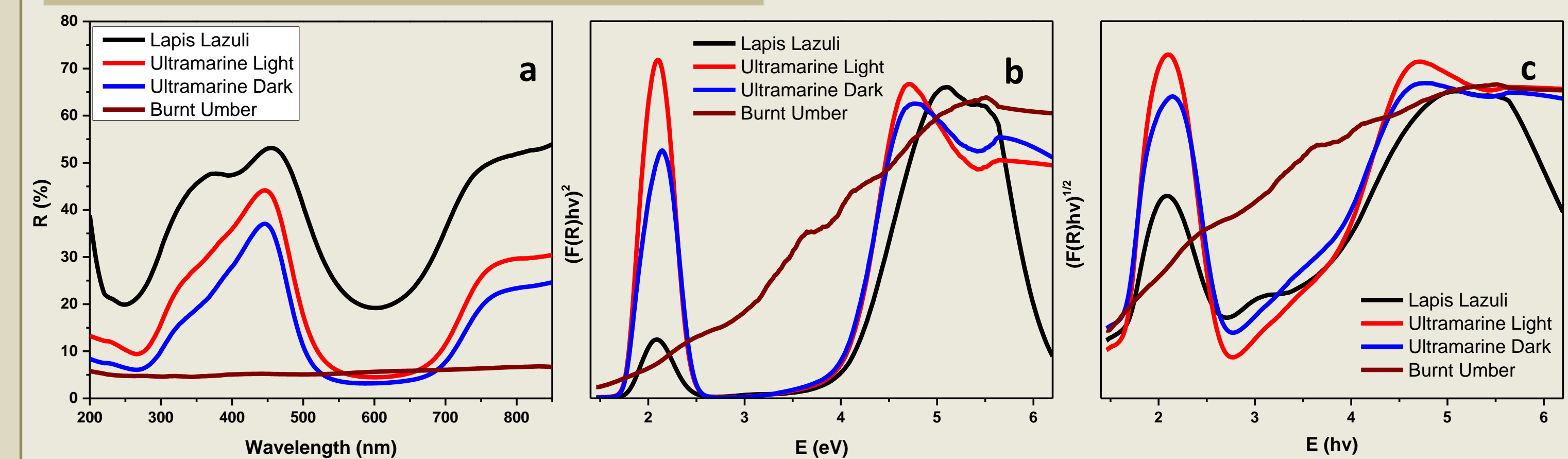
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Linearly Modulated Optically Stimulated Luminescence



The OSL signal was measured in the linear modulated configuration, in order to check the presence or the absence of a fast OSL component, appearing as a narrow peak at the initial stage of the stimulation. An excellent fast component is yielded for the case of Egyptian Blue and Lithopone, Lapis Lazuli, Ultramarines and Kaolinite. For the cases of the organic dyes of Indigo and Alizarin, conventional OSL was measured, without any pre-heating. Both materials indicate OSL signal with excellent features.

UV-Vis Spectrophotometry



Representative diffuse reflectance spectra (a) and Tauc plots for the determination of direct (b) and indirect optical band gaps of the pigments under study.

In the case of the pigments presented (natural and artificial lazurites), the optical band gaps have the same values, showing independence of the presence of inert materials. In the case of burned umber, the absence of indirect optical band gap is noted, while the calculated direct optical band gap is very narrow, ensuring the absence of very deep traps (VDT).