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LumStimAge project : TL/OSL imaging for heritage materials.

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With LumStimAge, the C2RMF will be able to offer a thermally stimulated (TL) and optically (OSL) luminescence imaging system focused on heritage materials (dating, characterization and provenance studies). Imaging should be able to identify the most efficient zeroed grains while taking into account the effects produced locally by microdosimetry.

LumStimAge project

Project description

The present project dedicated to TL / OSL imaging consists of the acquisition of the detection system (CCD camera and associated optics), and will include the physical optimization of the detection, calibration, signal-to-noise measurement system, but also the development or the adaptation of image processing algorithms to obtain a measurable intensity with a good spatial resolution.

The first applications will be devoted to composite materials, including raw architectural earth in connection with current research at C2RMF (stucco: ESPRIT project, raw bricks: MAFOUB project). Imaging should allow us to identify the grains that have undergone the most efficient zeroing during mortar fabrication, while taking into account the effects produced at the local level by microdosimetry.

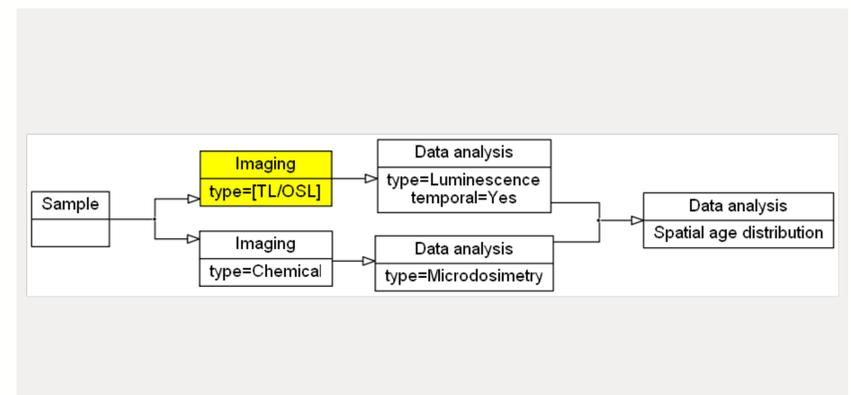
Contribution to materials for heritage

The contribution of the imagery will lead to expand our knowledge of the mechanisms implemented in dating and of the properties of archaeomaterials (interaction between matter and radiation: effect of alpha and X radiation, characterization of archaeomaterials: luminescence, palaeoheating):

- > control of the homogeneity of the grains within a sample;
- > identification of alpha emitting hot spots - detection of artificial irradiations;
- > distribution of radioactivity - microdosimetry;
- > emission characterization (reproducibility, stability over time, sensitivity);
- > single grain dating;
- > research on hybrid materials, identification of phosphors and their dosimetric and luminescent characteristics;
- > evolution of the luminescence according to the degrees of heating;
- > study of the kinetics of luminescence.

TL / OSL imaging

TL / OSL imaging, first developed internally by several laboratories (Clark-Balzan and Schwenninger, 2012), has recently been integrated as a module in commercial readers (Richter et al., 2013, Kook et al., 2015). The advantage of this method is that it can work directly on a raw sample, without grain separation, to evaluate the effects of micro-dosimetry by combining stimulated luminescence imaging with elementary imaging and autoradiography. On the other hand, there are optical aberration effects on produced images that distort measurements (Greilich et al., 2015). This requires "further exploration of image processing solutions based on more sophisticated algorithms" (Gribenski et al., 2015). This is what we plan to do by developing the potential of TL / OSL imaging to achieve sufficient sensitivity to quantify light intensity at each grain, even for young samples.



Data treatment - ©CAD A.Zink

Applications

The dating of raw earth materials (mortar, brick) is a current issue both in radiocarbon and luminescence (see for example the works of GDRE Architectural terracotta and new dating methods associating the universities of Bordeaux, Milan, Durham and Catania). As composite materials, they belong to the more general case of the dating of luminescent minerals in a complex matrix. Few people are interested in the dating of this type of material by luminescence, considering that the presence of different populations of grains resulting from partial resting or microdosimetric effects is problematic, although Urbanova (2015) shown the potential of dating mortars by single grain technique. Our TL / OSL imaging project is expected to go beyond the limits of the single grain technique (limited number of optical stimulations and need to work on isolated grains) by measuring grains in their environment.

Clark-Balzan L, Schwenninger J-L. 2012. Radiation Measurements. 47(9):797-802

Greilich S et al.. 2015 Quaternary Geochronology. 29:70-79

Gribenski N et al.. 2015. Radiation Measurements. 81:163-170. doi:10.1016/j.radmeas.2015.01.017.

Kook M, et al. 2015. Radiation Measurements. 81:171-177.

Richter D et al.. 2013. Geochronometria. 40(4):220-228.

Urbanová P. 2015. PhD Université Bordeaux III. 323p.

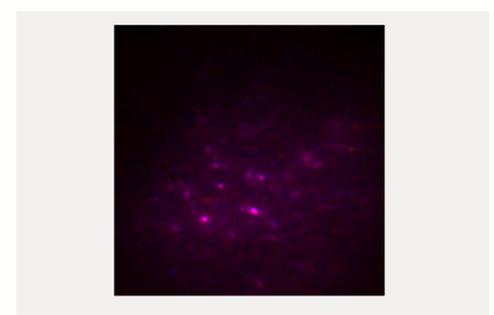
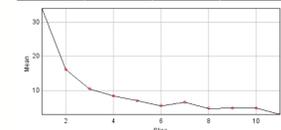
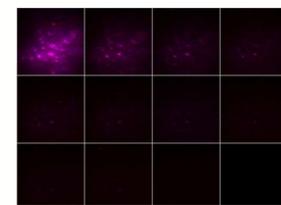


Image composed from the images obtained in IR-OSL (red channel) and in BL-OSL (blue channel); Fluvial sediment (Somme river, Epagne-Epagnette) irradiated at 300 Gy - ©CAD A. Zink



Luminescence decay during optical stimulation (Top - spatial distribution; bottom - intensity) - ©CAD A. Zink

Conclusion

The LumStimAge project proposes the acquisition of a TL / OSL imaging system to study stimulated luminescence phenomena (characterization, dating, provenance studies) in materials of heritage interest. In-depth research into image processing and algorithm development is needed.