Combining X-ray and Visual Hyperspectral Imaging for the Investigation of Painted Cultural Heritage Objects

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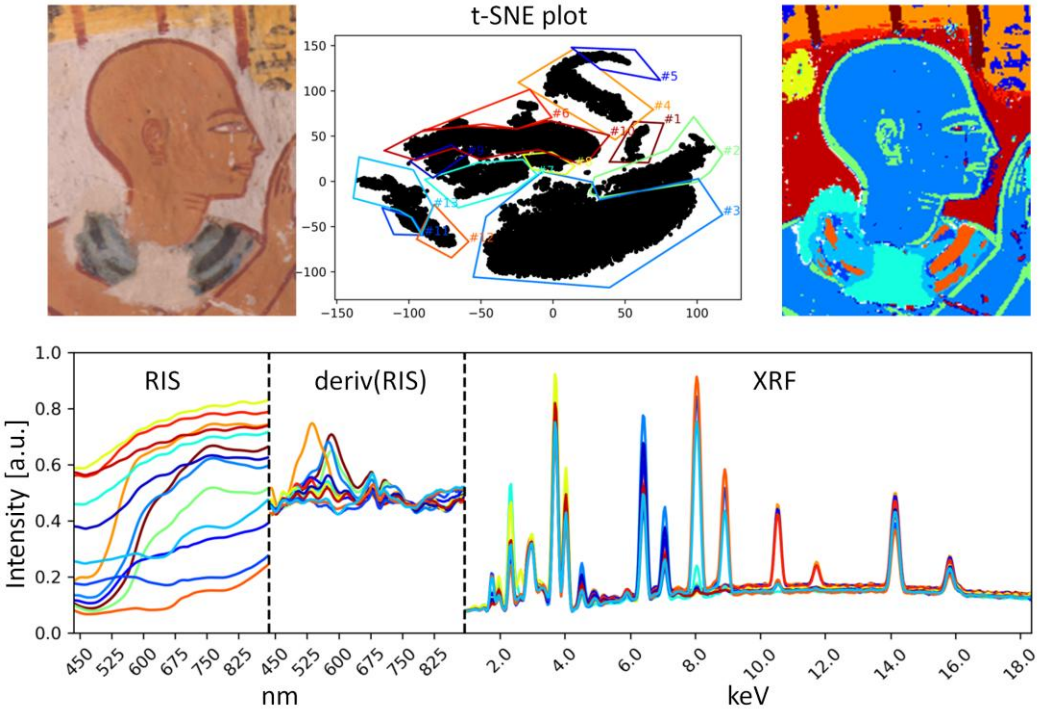
X-ray fluorescence (XRF) imaging and Reflectance Imaging Spectroscopy (RIS) in the visible and near IR range are well suited for the investigation of cultural heritage due to their non-invasive nature. Both are highly complementary: XRF gives clear elemental information, RIS allows for the identification of chemical compounds by their spectroscopic fingerprint. A joint usage allows one to employ the fast data acquisition of RIS for the rapid survey of objects and the joint information for reliable pigment identification.

However, for both methods data evaluation routines were established that are not suitable for the other, so that even if the data sets are spatially aligned their joint interpretation requires a comparison of evaluated data sets. We have shown that advanced algorithms from the field of machine learning, such as t-distributed Stochastic Neighbor Embedding (t-SNE), allow for a simultaneous evaluation of fused XRF and RIS data [1]. The potential and challenges of this approach and the methods needed to properly balance the contribution of different spectroscopic features, using e.g. Kernel techniques, will be discussed on the example of archaeological objects.



Evaluation of fused XRF and RIS data by t-SNE of a 19th dynasty wall painting from the Theban Necropolis, Egypt. The top row shows a visible light photograph, the t-SNE plot with manually selected clusters and the rule/cluster image. In the bottom row average cluster spectra are shown. Adapted from [1].

[1] M. Alfeld, S. Pedetti, P. Martinez, P. Walter, "Joint data treatment for Vis–NIR reflectance imaging spectroscopy and XRF imaging acquired in the Theban Necropolis in Egypt by data fusion and t-SNE" *Comptes Rendus Phys.* **19** (2018) 625–635. doi:10.1016/j.crhy.2018.08.004.