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A new method in cyclostratigraphy. TLS imaging of the lower Cretaceous Contessa quarry section (central Italy)

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Recent studies (Franceschi et al., 2009) have shown that Terrestrial Laser Scanner (TLS) systems operating in the infrared band are sensitive to the presence of clay minerals in limestones and marls. In particular, an inverse relationship is found between the abundance of clay and the intensity of the reflected laser beam. If good outcrop conditions are present (i.e. rock exposed and not covered by vegetation or debris), from TLS acquisitions it is possible to obtain information about the variations of the clay content along limestone-marl alternations.
This evidence has opened the possibility to apply TLS to cyclostratigraphic studies of hemipelagic limestone-marl alternations which are commonly found in the geological record. The abundance of clay is a significant sedimentological parameter that, in certain deep-water environments, substantially corresponds to terrigenous supply. Being able to estimate the variations of this parameter along a section provides an opportunity to seek evidence for Milankovich forcing.
We performed a preliminary test by scanning the lower Cretaceous hemipelagic succession of the "Scisti a Fucoidi" exposed in the Contessa quarry near Gubbio (central Italy), well known for the strong Milankovitch signal recorded in its lithological alternations (e.g., Grippo et al., 2004). TLS intensity data were transformed into a reflectance series to represent the variations of the laser intensity (and hence of terrigenous supply) along the considered sections. Time series analysis of the Contessa TLS reflectance series reveals clear cyclicity along the formation; the eccentricity signal is especially dominant, in accordance with previous studies.
The application of TLS technology provides the following special advantages:
Fast data collection (one day of field-work is sufficient to scan an approximately 50 m long composite section at a cm resolution).
Quick production of high-resolution and high accuracy 3D representations of objects placed several tens of meters from the instrument. Thus, perspective distortion is minimized, and inaccessible outcrops can be also surveyed. Moreover, cumulative errors produced by conventional measurement techniques are avoided.
Unlike conventional remote sensing techniques (e.g. satellite imaging) the acquisition process is done by an active sensor. This means that natural lighting variations do not influence the quality of the data.
It is worth stressing that the reliability of cyclostratigraphic studies depends on the possibility to analyze large, high resolution datasets, that describe long and continuous sections. Even when available, sections with such characteristics are often difficult to reach, and their accurate study can be very expensive in terms of time and money. Being fast and accurate, the TLS approach can overcome such drawbacks.
In sum, the results obtained from the Contessa section, together with the points mentioned above, suggest that a TLS-based cyclostratigraphy is easily applied to typical hemipelagic successions in good outcrop conditions, even if the succession cannot safely accessed (remote sensing), and could be used to rapidly enrich the collection of series with Milankovitch cycles needed to build a Mesozoic astrochronological time scale.

Franceschi M. et al., 2009. Discrimination between marls and limestones using intensity data from terrestrial laser scanner. ISPRS Journal of Photogrammetry and Remote Sensing, 64: 522-528

Grippo A., et al., 2004. Cyclostratigraphy and chronology of the Albian stage (Piobbico core, Italy). SEPM Special Publication, 81: 57-81