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Terrestrial laser scanning for high resolution cyclostratigraphy of chert in pelagic limestone series

L. Penasa (1), M. Franceschi (2), and N. Preto (1)
(1) University of Padova, Geosciences, Padova, Italy , (2) Museo delle Scienze, Trento, Italy (marco.franceschi@mtsn.tn.it)

We here propose the use of terrestrial laser scanning (TLS) for the mapping of chert on natural outcrops and for rapid extraction of its distribution along stratigraphic sections. The technique permits rapid production of high-definition time series for cyclostratigraphic analysis.
Chert, sometimes referred to as flint, is a widespread component of sedimentary successions. It is often found in deep water and pelagic sediments and is constituted by cryptocrystalline varieties of quartz. It is generally accepted that the origin of chert is principally biogenic; it derives from the slow alteration, through a process called maturation, of opaline organic components as tests and spicules under the influence of pore waters. Most often, chert forms nodules of various size, or more or less continuous layers. Its color shows strong variability (white, red, gray, black).
Although it could record paleoceanographic and climatic changes because of its biogenic nature, the cyclostratigraphic study of chert is largely neglected. This is mainly due to the difficulty of logging it. Hand logging is time consuming, but also, because of nodules' highly variable shape, lateral variability of chert abundance is large. Photographic image-processing techniques could help in principle, but they become difficult to use when chert has a color similar to that of the host rock.
Chert is easily detectable in TLS generated images because of its very low reflectivity at infrared (IR) wavelengths, also where the color of chert in visible light is close to that of the host rock. Thus, TLS data can be used to map the distribution of chert on an outcrop, and to compute its abundance along a stratigraphic section. The ultimate result of such data processing, for which a suite of original procedures was implemented, is a stratigraphic log that is suitable for time series analysis.
A section in the early Cretaceous Maiolica Formation of Central Italy (Gubbio) was considered as preliminary case study for this novel approach. TLS acquisitions were converted into chert-abundance series and cyclostratigraphic analysis was carried out.
Power spectra display spectral peaks with ratios that well fit those expected for the Milankovich cycles of precession, obliquity and eccentricity, and imply sedimentation rates in agreement with bio- and magnetostratigraphic studies from literature.
Results are promising in prefiguring TLS as a quick and accurate method to study the factors that steer the abundance of biogenic silica in sedimentary rocks. The possibility to undertake cyclostratigraphic study of chert in a quick and efficient way may contribute to the refining of the global astrochronological time scale, by allowing the cyclostratigraphic study of successions that were so far neglected. This could be particularly important in the Cretaceous, where chert is widespread and represents a prominent character of well-known pelagic series, like those of the Chalk in Europe and of the Western Interior Basin in the USA.