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Is hyperspectral imaging a possible new approach for fire reconstruction studies?

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Lacustrine sediments contain a wide range of proxies that permit paleoenvironmental reconstructions such as paleofire at very high temporal resolution. However, to achieve this, it is necessary to develop fast, non-destructive and high-resolution analysis methods. In this study, we develop a new fire proxy by studying a lacustrine core sampled in the Esterel Massif, SE France, an area that was affected by two recent fire events in 1987 and 2003. For this purpose, we searched for charcoal deposited and preserved in lake sediments by combining a number of complementary methods including: classical macrocharcoal tallying, scanning spectrophotometry and scanning hyperspectral image analyses. Macrocharcoal quantification is destructive and time-consuming, and only provides intermediate-resolution (1 cm) data. Spectrophotometry, used classically to quantify colour, is non-destructive, very fast and provides data with high resolution (1 mm according to the device). Hyperspectral data have the same advantages as spectrophotometry but offer higher spatial resolution (57-μm pixel size) with high spectral resolution (3 nm). Our study focused on a new fire proxy (hyperspectral index) obtained through hyperspectral investigations: the trough area method. The method involves the calculation of the area between the reflectance values and the continuum between 650 -700 nm, which corresponds to the quantification of a trough in red reflectance produced by chlorophyll a and its by-products. First derivative spectra allowed the quantification of red reflectance around 675 nm linked to chlorophyll a and its diagenetic products. Moreover, first derivative spectra show this wavelength is also affected by the presence of altered organic matter, because the reflectance at 675 nm decreases with organic matter alteration processes, such as combustion. The trough area method is suitable for detecting burned organic matter by quantifying the chloropyll signal dilution by charcoal signal. Thus, this adaptation of trough area could be applied in fire reconstruction studies.