Using reflectance spectroscopy for the reconstruction of penguin palaeoecological process in Antarctic ornithogenic sediments

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The present study explored the application of the rapid, cost-effective, non-destructive and simultaneous technique of reflectance spectroscopy within visible-near-infrared region to infer penguin palaeoecological records in the maritime Antarctic. A total of 106 samples taken from four sediment cores (Y2, Y2-4, Y4, AD3) on the Ardley Island were measured by both chemical and spectral methods. These cores were previously reported to be influenced by penguin guano, and nine elements including sulfur (S), phosphorus (as P_2O_5), calcium (as CaO), copper (Cu), zinc (Zn), selenium (Se), strontium (Sr), barium (Ba), and fluorine (F) were identified as bio-elements; their concentrations could be used as inorganic geochemical indicators for tracking historical penguin population change. The reflectance (r) and its derived indexes were employed to develop calibrations for predicting nine bio-element concentrations, using stepwise multiple linear regression (s-MLR) and principal component regression (PCR) approaches. R between optimal spectra-predicted and chemically analyzed concentrations were Ba: 0.894, all the other eight elements >0.954 for s-MLR; Ba: 0.926, all the other eight elements >0.963 for PCR.

Furthermore, principal component analysis (PCA) was performed on all the reflectance spectra data and the results showed that the first two factors were able to account for 98.9% of the variance of the data. The first PCA factor(PC1), accounting for 95.8% of the total variance, could be explained to bear the information of the content of penguin guano, and thus the PC1 score against depth of the samples (curve A) indicated the fluctuation of historical penguin population. In addition, by using spectra of pure guano and pure soil, these absorbance spectra data (log1/r) of ornithogenic sediments were linearly separated to guano part and soil part. The penguin population change inferred from the separated guano proportion (curve B) was consistent with curve A, and both curves showed similar historical change trends as inferences from inorganic elements and isotopes. Overall, this study demonstrated that using reflectance spectroscopy to infer palaeoecological information recorded in Antarctic ornithogenic sediments is feasible.

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The coupling between plate subduction and intraplate evolution in eastern China

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Plate interactions along subduction zones usually cause deformations of overlaying crusts as shown in the Andes. Numerical modelling shows that plate interaction during plate subduction is of critical importance for intraplate tectonic evolutions of the American continent [1].

Eastern China was an active continental margin related to the subduction of the paleo-Pacific plate under Eurasia from Jurassic to Cretaceous. This continent is well known for the removal of subcontinental lithosphere mantle with complicated geological evolutions, which leads to different models, ranging from extension to subduction-related compression and crust delamination etc. We find that the Cretaceous tectonic evolution in eastern China matches remarkably well with the drifting history of the paleo-Pacific plate. The most pronounced phenomenon is that the eastern China large-scale orogenic lode gold mineralisation occurred at about 125 Ma [2], concurrent with the major shift in the drifting direction of the subducting paleo-Pacific Plate [3] and the formation of the Ontong Java Plateau. Given lode gold deposits usually formed onset of compressional or transpressional deformations, the lode gold deposits dated the major tectonic change from extension to transpression in eastern China [4], consistent with the subduction regime and other geological records in the region. The Early Cretaceous drifting history of the paleo-Pacific also matches with other tectonic and magmatic evolutions in eastern China, suggesting that the major geological events in eastern China in the Early Cretaceous have been mainly controlled by the subduction of the paleo-Pacific plate, and that plate interactions are important driving forces for intraplate tectonic evolution in general. This provides a new angle of view to understand the tectonic evolution of the eastern Euroasian continents, e.g., the mechanism behind lithosphere thinning in eastern China as well as the evolution of the Tan-Lu Fault.

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