Applying Raman Spectroscopy to Modern– and Palaeo–charcoals Associated with Wildfire Activity

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INTRODUCTION

• Raman spectroscopy has been used widely to characterize the thermal maturation of organic matter (1) – yet the relationship between Raman parameters, wildfire–derived charcoals, and their geothermometry is undiscussed.

• Here we display the creation of a Raman geothermometer (RamChar) from Calluna vulgaris charcoal, and its application to wildfire–derived charcoals isolated from the Boltysh Impact Crater, Ukraine.

BACKGROUND

• Raman spectroscopy of organic carbon relies on the characterization of the relationship between two spectral peaks – D and G (see Fig. 1). Changes to the peak width (FWHM), ratios of intensity (ID/IG) and area (AD/AG), and distance between peaks (G–D) offer an insight into sample thermal maturity.

• The Boltysh Core represents Danian lacustrine infill and subsequent ecosystem recovery following a meteorite impact, occurring a few thousand years prior to Chicxulub. Significant isotopic and palynological research has revealed a period of climatic warming (Dan–C2 hyperthermal) across the centre of the core (2,3).

RESULTS

Geothermometer

• Raising formation temperature:
  • Increases intensity of the D–peak.
  • Reduces the width of both peaks.
  • Increases the distance between both peaks (G–D).

• D–FWHM and G–D remain the best fit parameters for multiple–linear regression against temperature (RamChar).

• Trends for each parameter are very similar, but there are variations depending on the origin material (i.e. root).

Boltysh Application (Fig. 2.)

• Small variation in temperature across depth, with a median temperature of 752°C - typical of crown–fire systems.

• Temperature variation at depths 405, 407 and 411m show evidence of both surface (400–600°C) and crown (<600°C) wildfire systems.

• Crown fires are consistent with palynological data at this depth, indicating a presence of arboreal angiosperm species (2,3).

REFERENCES


Fig. 1: Raman spectra of charcoal produced at varying temperatures.

Fig. 2: Changes in Raman parameters with depth in a section of Boltysh core, and relation to the calculated wildfire temperatures.