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Shedding new light on the K-Pg extinction event: application of modern fire science

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The impact on fire on the earth system is a key component to understand the long term evolutionary history of our planet. However, in order to fully explore the role of fire, it is essential to draw on the significant existing literature and methods available to both palaeontologists and fire scientists if we are to better interpret the fossil record of life.

A novel cross-disciplinary approach was developed to investigate the extent to which forest materials may have been ignited by the thermal radiation delivered by the collision of an extra-terrestrial body on the Yucatán Peninsula at the end of the Cretaceous period. A novel experimental approach was developed through close collaboration between earth scientists and fire safety engineers that drew on well established procedures for assessing material flammability. Through close working in both experimental design and interpretation, a new method to rapidly and effectively assess the expected ignition behaviour resulting from this event was developed.

Prior modelling of the impact indicated that the impact resulted in a range of heat flux pulses, dependent on the angle of impact and melt spherule distribution and was shown to vary as a function of geographical location. These data were used as an input to a series of laboratory experiments undertaken at the Rushbrook Fire Laboratory at the University of Edinburgh. Building on existing material flammability assessment methods, modifications were made to the operation of the FM Global Fire Propagation Apparatus to allow these time-dependent heat flux pulses to be reproduced in the laboratory under controlled conditions of thermal input and burning environment.

The results indicate that the ignition propensity of a particular biome is strongly dependent on both the fuel available and the heat pulse. It was observed that thin, dry fuels could be ignited easily under almost every condition but that live fuels could not. Live fuels could only be ignited by the less intense, long duration pulse that occurred at locations far from the impact site. Not only has this resulted in new insights into building our understanding of the end Cretaceous mass extinction, but it has also yielded a simple experimental method that rapidly allows investigation of the ignition propensity of specific ecosystems of utility to the fossil record. Finally, by applying fire science techniques to this problem, the underlying physical phenomena can be investigated allowing greater confidence in extrapolation of data to other scenarios.

It is clear that such collaborative approaches in developing new experimental procedures drawing on existing knowledge from diverse research fields has allowed for rapid progress in interpreting the fossil evidence of fire through earth history. In addition to advancing the state of the art in palaeontology, this work has resulted in new developments in fire safety science clearly indicating the benefits of cross-disciplinary experimental research methods.