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Hot rock and wildfires: assessing the potential of the proximal Cretaceous-Palaeogene impact melt spherules to ignite wildfires

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It is generally accepted that an extraterrestrial body collided with the Earth 65 m.y. ago and that the 200-km-wide Chicxulub Crater on the Yucatan Peninsula, Mexico, is the mark of this impact. This impact blasted melted asteroidal and target rock debris across the planet, depositing the Cretaceous-Palaeogene (K-Pg) boundary impact rock layers. Several models have suggested that the thermal radiation released by the K-Pg impact ought to have been sufficient to have ignited wildfires locally, if not globally. However, a more recent model by Goldin and Melosh (2009) suggests the thermal flux to the ground surface was a maximum of 19 kW m sq. This model is consistent with the record of wildfire indicators analysed from K-Pg boundary impact rocks, which show little evidence for wildfires associated with this event across the western interior of North America.

The K-Pg impact is known to have formed thick proximal ejecta deposits consisting of large (typically 1-10mm) melt spherules up to 2000km in distance from Chicxulub crater. This zone includes areas of land that are known to have been emergent from the ocean at this time and where forests may have come into direct contact with the hot ejecta. Here we test the ability of these large super-heated melt spherules to ignite wildfires in the areas proximal to Chicxulub crater using laboratory experiments. Metal ball-bearings of a variety of sizes (4.4-19.1mm in diameter) and heated to a variety of temperatures (500-1100oC) were dropped onto cellulose and pine needle fuel beds. The former is a well-characterised “laboratory” fuel while the latter is a natural fuel relevant to wildfire spread. The temperature of the fuel beds was recorded (via thermocouples) at eight locations moving away from the spherule impact point in the cellulose fuel beds, whereas mass loss of the fuel bed was used to characterise ignition in pine needle fuel beds.

Our results suggest that vegetated areas receiving impacts of spherules 4.4mm or greater in diameter may have had the potential to be ignited. Based on the experiments using pine needles it is more likely that only areas receiving very large melt spherules 9.5mm or greater would have been ignited. Distal K-Pg ejecta sites such as those throughout the western interior of North America, contain spherules that are typically sub-millimeter in diameter, such spherules are unlikely to have been able to cause ignition of vegetation. These results highlight the potential of large melt spherules as a source of wildfire ignition not only following the K-Pg event but also following other extraterrestrial collisions with the Earth.