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Wildfires Caused by Formation of Small Impact Craters: A Kaali Crater Case

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Formation of ~200-km Chicxulub 65 Ma ago was associated with release of significant amount of thermal energy [1,2,3] which was sufficient to start wildfires that had either regional [4] or global [5] range. The evidence for wildfires caused by impacts smaller than Chicxulub is inconclusive. On one hand, no signs of fires are associated with the formation of 24-km Ries crater [6]. On the other hand, the Tunguska site was burned after the impact and the numerical models of the bolide-produced thermal radiation suggest that the Tunguska-like event would produce a thermal flux to the surface that is sufficient to ignite pine needles [7]. However, in case of Tunguska the only proof for the bolide starting the fire comes from an eyewitness description collected many years after the event. Some authors [8] suggest that this fire might have been caused "normaly" later during the same year, induced on dead trees killed by the Tunguska fall. More recently it was observed that the Chelyabinsk meteor [9] - smaller than Tunguska event - did not produced a fire.
In order to explore this apparent relationship in more detail, we have studied the proximal ejecta from a 100-m in diameter, ~3500 years old [10] Kaali crater (Estonia) within which we find pieces of charred organic material. Those pieces appear to have been produced during the impact, according to their stratigraphic location and following 14C analysis [19] as opposed to pre- or post-impact forest fires.
In order to determine the most probable formation mechanism of the charred organic material found within Kaali proximal ejecta blanket, we:
1) Analyzed charcoal under SEM to identify the charred plants and determine properties of the charcoal related to the temperature of its formation [11]. Detected homogenization of cell walls suggests that at least some pieces of charcoal were formed at >300 °C [11].
2) Analyzed the reflectance properties of the charred particles in order to determine the intensity with which pyrolysis occurred [12,13]. Initial mesurements suggest some particles are partially charred. This may be consistent with a short thermal exposure.
3) Numerically estimated entry parameters and thermal radiation from the bolide that reaches the surface of the impact site.
4) Performed numerical modeling using iSALE of the Kaali crater formation and ejecta distribution, especially in terms of the temperature of the ejected particles [14].

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