THE DISCOVERY OF A LATE HOLOCENE IMPACT CRATER NEAR WHITECOURT, ALBERTA

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Introduction: Based on magnitude-frequency relations, small terrestrial craters should be more common than observed. For example, it is predicted that over 200 craters 60 m in diameter should have formed on the Earth's surface during the Holocene [1]. However, of the approximately 175 known impact craters, there are only 5 from the Holocene with diameters <100 m; it appears that a component of the Holocene impact record is missing. We report the discovery of a well-preserved late Holocene impact structure located in a forested area near the town of Whitecourt, Alberta (54°00' N, 115°36' W).

The Whitecourt Meteorite Impact Crater (WMIC): Although undetectable using visible imagery, a bare-earth model of the ground surface obtained from airborne LiDAR (Light Detection and Ranging) data clearly reveals a bowl-shape crater with a diameter of 36 m and a depth of 6 m. The target material for the crater is deglacial sediments associated with the retreat of the Laurentide Ice Sheet.

Stratigraphy and age: The crater fill is represented by a pebble-diamict to a depth of ~2.9 m. Below this depth is a sharp transition to a well-sorted medium sand which continues, uninterrupted, to a depth of at least 5.4 m. Rare glassy fragments have been found within the diamict in the crater center; the amorphous nature of this material has been confirmed by XRD and polarizing light microscopy. The glass fragments have an amber color in transmitted light and range from <0.1 to 0.5 cm diameter. Glass has not been observed at a depth greater than ~3.1 m. We interpret the ~2.9 m transition, represented by a change in sediment from diamict to sand, to be near to the base of the transient crater. The presence of glass to a depth of 3.1 m is consistent with this interpretation.

Two radiocarbon ages of 1130 ± 25 and 1080 ± 25 ^{14}C yr BP (UCIAMS 40058 and 40059, respectively) were obtained on charcoal from the A-horizon of a paleosol buried by impact ejecta. These data provide a concordant maximum age for the overlying ejecta of ca. 880-990 AD, indicating the impact event likely occurred within the last thousand years.

Meteorites: Meteorites are embedded to depths reaching 25 cm in the surface surrounding the crater rim to a distance of 70 m. A total of 74 meteorites (IIIAB Om iron) with a combined weight of 5.4 kg have been recovered thus far. The meteorites have an angular morphology, and range in size from < 1 cm to 12.5 cm in greatest dimension and in mass from 0.1 to 1196 g.

Conclusions: The WMIC represents the fall of an iron meteoroid which fragmented at low altitude, showering the immediate area with angular fragments. The main mass, with an estimated diameter of 1.1 m (after [2]), formed the crater. This study demonstrates that LiDAR may be a critical tool for searching for the missing component of young, small impact craters predicted from magnitude-frequency relations.

References: [1] Bland P. A. and Artemieva N. A. (2006) *MAPS*, 41:607-631. [2] Collins G. S. et al. (2005) *MAPS*, 40:817-840.