Mount Baldy Core Description

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Background:
A "hole" was found and marked by NPS staff during an exploratory probing exercise of the stoss (north; windward) eroding slope of Mount Baldy during the week of 5 August 2013. The hole was described as similar to the one associated with the accident of Nathan Woessner on 15 July 2013. NPS staff reported reaching in to the hole which had a diameter of ~12in (0.30m) and recovering some organic material. Upon arriving at the site the hole was no longer visible. The ground near the flag was probed within ~2ft (0.61m) radius. A weak spot where the probe could easily penetrate the ground with minimal pressure was found. A vertical core was taken at this location to search for any evidence of a buried decaying tree, the operating hypothesis for the accident.

Methods:
It is important to note that the method of coring was adapted in the field to attempt to capture some data associated with these holes. The proper equipment for coring and extracting the core in dry sand was not available but could be used in future studies to improve sediment recovery and depth measurements. Aluminum tubing was hand driven in to the dune. Multiple flights were attempted and compiled for a vertical profile. Between flights efforts were made to minimize the time for sand to slough in to the open hole. Nonetheless the depth measurements should be considered best estimates with error allowed for slough.

Results:
The total depth cored was ~16.82ft (5.13m). A total of 7.51ft (2.29m) was augered from the surface before the first core tube was inserted. Material that sloughed in to the hole could not be accounted for during augering. A total of 9.31ft (2.84m) of sediment was recovered from 3 flights that individually measured 1.47ft (0.45m), 3.44ft (1.05m), and 4.40ft (1.34m) in length with slough removed. The cores are shown in Figure 1. A well-developed buried soil horizon (paleosol) was visible at a total depth of 9.92ft (3.02m) below the surface (Figure 2). There was no evidence of a tree or tree-like material at the paleosol surface and the sediment was generally undisturbed. Small fragments (<1 inch) of organic material similar to wood or bark were found in the core at a total depth of 12.1-12.43ft (3.69-3.79m) (flight 2). The remainder of the core was seemingly undisturbed dune sand dominated by medium sand (ASTM No. 60; 0.50-0.25mm).

A bulk organic sample was collected from the buried soil horizon (paleosol) at ~ 9.92ft (3.02m) and was submitted to Beta Analytic Radiocarbon Dating Laboratories. The age of the sample collected from the paleosol was reported as 3690 +/- 30 14C yr BP or 4080 to 3980 cal yr BP. This paleosol has generally been considered to be the Holland Paleosol described by Arbogast et al. (2004) as forming between ~3000 and 300 cal yr BP.

Summary:
A single core was collected from Mount Baldy in a “soft spot” within ~24 inches of the site where a hole was found by NPS staff two days prior to coring. The hole was no longer visible at the time of coring. The total depth cored was ~16.82ft (5.13m) and 9.31ft (2.84m) of sediment was recovered from a hand-driven core which consisted of three separate flights. In general the sand seemed undisturbed aside from slough created between flights during coring. The same paleosol that is visible at varying elevations at the surface across the stoss (windward; north) face of Mount Baldy was found at a depth of ~9.92ft (3.02m) from the surface. The paleosol was undisturbed in the core and did not contain woody debris or evidence of a decomposing tree. The buried paleosol is currently interpreted as the Holland Paleosol described by Arbogast et al (2004) though the age of 4080 to 3980 cal yr BP is notably older than those reported in previous studies. Small woody fragments interpreted as bark found at a depth of 12.1-12.43ft (3.69-3.79m). These fragments likely are in place from a previous generation of dune movement, prior to stabilization and unrelated to the formation of the paleosol.

Unfortunately this core does not provide clear insight in to the origin of the observed hole. The objective was to collect a core from within an open hole. However the observed hole had collapsed or filled in with aeolian sand by the time of coring. While the core was collected in the vicinity of the hole, it likely did not capture the exact location. It can be concluded that the holes are short-lived and may remain open for less than 24 hours before filling in with dry sand. The fact that the paleosol was undisturbed may suggest that the occurrence of holes is connected to processes operating at the paleosol surface rather than below it. Close examination of the paleosol surface through coring or ground-penetrating radar is recommended. Also, mapping the GPS locations of the two known holes and any future holes against the paleosol depth could provide additional information on how these holes occur.

(a) (b)

Figure 1. Core images (a) flights 1 and 2 and (b) flight 3. Depth measurements are from top of core and include slough. For proper measurements see Results.

Figure 2. Paleosol from flight 2. Upward curve on edges of the core tube are caused during driving of the core.