Dune Soils and Prehistoric Agriculture in Petrified Forest National Park, Northern Arizona

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Introduction

Recent and previous survey work in the Petrified Forest National Park has shown that archaeological sites are often found in areas with extensive dunes, suggesting that these are favorable environments for habitation. This paper examines sediment characteristics in three study areas to determine the potential for dry-farmed dune agriculture. Dune agriculture is known from ethnographic accounts of Hopi agriculture, and has been inferred archaeologically, but there is very little archaeological evidence to document the presence of dune agriculture.

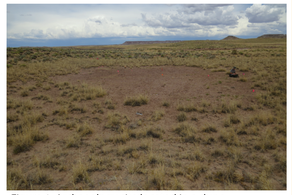


Figure 1: Archaeology site located in a dune blowout. Many archaeology sites in the park are located in similar dune blowouts.

Location

The Petrified Forest is located on the southern edge of the Tusayan dune field in northeastern Arizona. Though there are several studies of these dunes, few extend to the region of the Petrified Forest, yet the area of the park contains extensive dune deposits. Archaeology sites in the park are often found in association with dunes, and include sites dating to the Basketmaker II through Pueblo III periods (c. AD 200-1200).

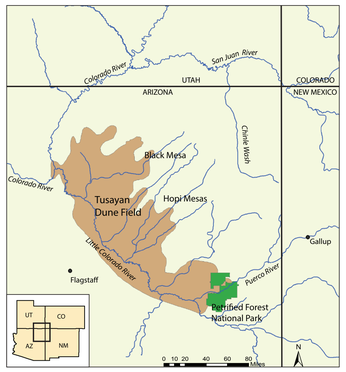


Figure 2: Map showing the Petrified Forest national Park in location to the Tusayan Dune Field. (Modified from Breed et al. 1984)

Dune Agriculture

Ethnographic research has shown that the Hopi farm sand dunes that contain a surface layer of sand underlain by a finer textured clay or loam. The sand acts as a mulch to prevent evaporation, while the clay retains water needed for seed germination (Bradfield 1971; Dominguez and Kolm 2005; Hack 1942). Hopi farmers often determine whether to plant a dune based on key plant taxa which indicate good soil moisture retention (Bradfield 1971; Dominguez and Kolm 2005; Hack 1942). Soil layers with alternating fine and coarse textures result in permeable layers and capillary barriers that prevent vertical movement and loss of water consistent with retention of water needed for seed germination (Dominguez and Kolm 2005).

Methods

- Sediments examined in three study areas to begin documenting dune environments, to determine 1) periods of stability based on soils and weathering and 2) potential for dry-farmed agriculture
- Sediments and soils described in the field using a bucket auger and exposed profiles
- Laboratory analysis of calcium carbonate and organic matter analysis for four soil profiles (Singer and Janitzky 1986) [further laboratory analysis planned in the future]

Results

Study Area 1

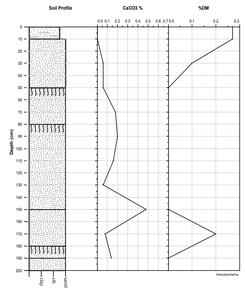


Figure 3: Profile AS12-1 in a dune crest

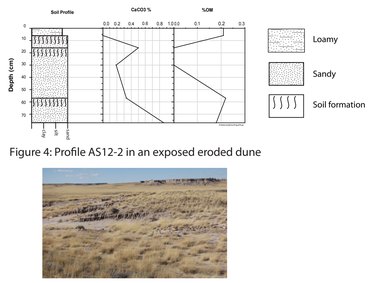


Figure 4: Profile AS12-2 in an exposed eroded dune

Figure 5: Photo of dunes in study area 1

- Stratified, weakly developed, buried soils with weak to moderate structure, low organic matter, and low calcium carbonate.
- Texture does not show marked changes or horizons with increased clay or silt content, but subtle texture changes may be obscured by use of the bucket auger. Probably some clay accumulation.

Study Area 2

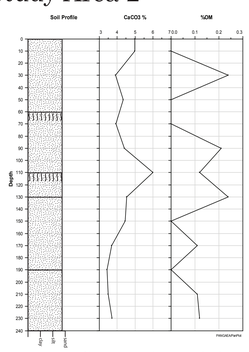


Figure 6: Profile AS12-3 in the crest of a dune

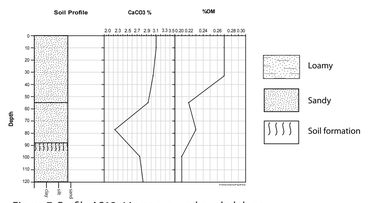


Figure 7: Profile AS12-4 in an exposed eroded dune

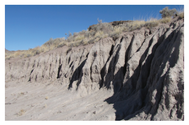


Figure 8: Photo of dunes in study area 2 showing buried soils

- Stratified, weakly developed, buried soils with moderate structure, low organic matter, and low to moderate calcium carbonate.
- Texture suggests some clay accumulation. Distinct changes in texture between horizons cannot be observed with the bucket auger.
- Increased pedogenisis marked by greater carbonate accumulation and soil structure suggest that dunes in area 2 are older than those at area 1.

Study Area 3

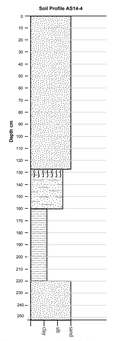


Figure 9: Profile AS14-4 in the crest of a dune

Figure 10: Profile AS14-5 in an interdunal low

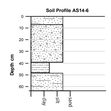
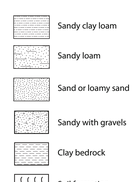


Figure 11: Profile AS14-6 in an interdunal low

Figure 12: Photo of study area 3 showing dune crest and interdunal low spot with clay accumulation



- Weakly developed buried soil within dune.
- Some textural change, with stratified deposits of sandy clay loam and loamy sand.
- Interdunal low spots have shallow depth to bed-rock.
- Laboratory analysis pending.

Discussion

Previous work has included conflicting suggestions regarding which soils in the park are favorable for agriculture (Burton 1990, Jones 1996, Wendorf 1953). Extensive agriculture has been inferred prehistorically within the park, but not studied directly.

Results of this pilot study show weakly developed stratified buried soils within some dunes, suggesting alternating periods of erosion and stability. Dunes in the Petrified Forest contain higher clay content that is typical of many dunes, likely due to the nearby eroding siltstone and mudstones. Buried soils, and some instances of stratified textural variation suggest that the dune environments in the Petrified Forest National Park may have been conducive to dune agriculture, which requires coarser sand underlain by finer clay or loam, as well as multiple layers of varying texture.

Future work will include examination of dune sediments in many more areas with extensive archaeological deposits to determine the relationship between archaeological site location and sediment characteristics.

Figure 13: Interdunal low spots collect finer particles, organic matter, and water. These may contribute to layers of finer textures in stratigraphic dune deposits. Alternating finer and coarser sediment would facilitate dune farming. Photo is near study area 3.

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