**Supplementary Material**

**Methods**

*Micromorphology*

Micromorphology samples must be collected as undisturbed sediment blocks in order to preserve their original structural characteristics. Rarely, large intact peds could be pulled from the wall and wrapped in toilet paper and packing tape. When the sediments were too friable to be collected in this manner, plaster wraps or electrical junction boxes were used for sampling. For a more detailed description of collection methods see Goldberg and Macphail (2003). Laboratory preparation methods were followed according to Miller and Goldberg (2009). The samples were oven dried at 65ºC for 48 hours. Then, the samples were impregnated using a 7:3 mixture of unpromoted polyester resin and styrene (Advance Coatings, Westminster, MA). Additionally, 5 ml of methyl ethyl ketone peroxide was added to every liter of the mixture as a hardening agent. The samples were left in a fume hood for seven days to allow the resin to absorb into the samples through capillary action. Finally, the impregnated blocks were oven dried at 65ºC for 48 hours. The samples were sent to Quality Thin Sections (Tucson, AZ) and cut into oversize (51x76cm) thin sections. An additional 4 standard size (27x46 mm) thin sections, BM1, BM2, BM3, BM6, were provided for this study by J. Ballenger. All thin sections were analyzed using an Olympus BX51 petrographic microscope equipped with transmitted polarized light and incident fluorescent light. The thin sections were described using the terminology from Stoops (2003). The abundance of the coarse components was determined using standard point counting techniques.

*Carbonate content*

Bulk samples were collected from all sites except from the locations where J. Ballenger provided thin section samples. The bulk samples were oven dried at 65ºC for 48 hours. The abundance of calcium carbonate in the samples was determined using a Chittick apparatus (Machette, 1986). This method uses the digestion of carbonate via HCl to produce CO2 gas. The amount of gas produced from a known sample weight is then used to calculate carbonate content.

*Organic matter content*

The amount of organic carbon in the samples was measured using the Walkley-Black method (Janitzky, 1986). This method uses potassium dichromate and sulfuric acid to oxidize the organic carbon in a sample. After the reaction is complete, the volume of the unused solution is determined using titration with ferrous sulfate. This amount is then used to calculate the abundance of organic carbon. The amount of organic matter is generally considered 1.724 times the amount of organic carbon present (Janitzky, 1986).

*Site chronologies and radiocarbon dates*

Black mats with well documented radiocarbon age control were specifically selected for this study in order to better constrain the chronologic relationship between black mat formation and the YDC. A total of 68 radiocarbon ages were collected for the 20 different sampling locations in this study. An additional 93 dates from all the published radiocarbon dates on black mats from the region (Nevada, Arizona, southern California, Texas and New Mexico) were included for a total of 161 black mat ages (Fig. 10). The radiocarbon ages were calibrated using Calib 7.0.4 and reported using the 2σ cal age range and the Intcal113.14c calibration dataset (Reimer et al. 2013). Any calibrated age ranges with P<.05 were not reported and only the highest P age range was reported in Figure 7.

**Works Cited**

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Stoops, G. V. M. J., 2003. Guidelines for Analysis and Description of Soil and Regolith Thin Sections. Soil Science Society of America, Madison.

**List of Supplementary Tables**

Table S1. Micromorphological descriptions of black mat thin sections. For an overview of the terminology used see Stoops (2003).

Table S2. Summary of black mat ages used in Fig. 7.

Figure S1. Sampling locations at a) Murray Springs archaeolgical site. Based on Figure 1.3 from Haynes 2007c. b) Blacwater Draw archaeological site based on Figure 3.7 in Holliday 1997. c) Lubbock Lake archaeological site. Based on Figure 2 from Holliday 1995.

Figure S2. Sampling locations in the San Pedro Valley, Arizona.