The Water Canyon Paleoindian Site: A Significant Archive of Paleoclimatic Data for the Early Holocene in West-Central New Mexico / 2013 GSA Conference / Denver

By Robert Dello-Russo, PhD and Susan J. Smith

Slide No.	Talking Points
1	Good Morning / I want to thank all of you for attending and thanks to the symposium organizers for their efforts / I'd like to talk today about a recently discovered archaeological site in western NM that contains multiple Paleoindian components spanning the Late Pleistocene - Early Holocene transition together with an extensive wet meadow deposit that provides an excellent archive of paleo-environmental & paleo-climatic proxy data.
2	Here is a map of NM, with the Water Canyon site (in red) (point to it) and some other locations of paleoclimatic records in NM that span the Pleistocene-Holocene transition. This includes records from the Plains of San Augustin to the west and the nearby Scholle Cienega site to the east.
3	As illustrated in the geological cross-section (based largely on an illustration by Mark Person at NMT), the WC site is found in a relatively small wedge of fluvial sediments in the center of a structural basin between the Magdalena and Socorro Mts. (point to these). The name of the site derives from the name of the main drainage issuing from the Magdalena Mts. The black dashed line in the figure immediately below the present ground surface (point to it) represents the estimated prehistoric level of the water table. The site occurs where the alluvial fan from the Magdalena Mts. is being truncated by small tributaries of the Water Canyon drainage. The eroding edge intersects the late Pleistocene - early Holocene water table revealing a buried wet meadow deposit, or black mat.
4	Here is an aerial view of the topography surrounding the WC site, although the vertical scale is exaggerated. You can see the Water Canyon drainage here (point to it), and another large drainage, Nogal Arroyo, here (point to it). The Magdalena alluvial fan is being eroded at its lower, eastern edge and exposures of the black mat have been found in numerous places.
5	Here is topographic map of the same region that we just looked at, with an estimation of the extent of the wet meadow deposit (point to it) during the late Pleistocene - early Holocene. As you can see, it was a landscape scale feature and - for the Southwest - was a focal point on the landscape that supported diverse vegetation, fauna and human hunter-gatherers. (Point to WC site)
6	This image shows the fossil wet meadow deposit - or black mat (this highly organic stratum) (point to it) - in the north wall of No Name Arroyo. Our first radiocarbon samples, faunal elements and proxy data were recovered here.
7	These images show the two major excavation areas at the site - Locus 1 along No Name Arroyo and Locus 5 to the northeast of Locus 1. Locus 1 contains an early Holocene (9200 yrs) bison bone bed associated with the black mat at 1.5 m below the surface. Here it is again in the south wall (point to it). Locus 5 contains a terminal Pleistocene (11,100 yrs) bison bone bed associated with the black mat at 3.7 m below the surface.
8	The species of bison found at Water Canyon is *Bison antiquus* in both cases. We directly dated the more recent bone bed by cutting a piece of the femur and dating the well-preserved collagen. In the same deposit, we also recovered a rhyolite biface fragment on which we identified bison blood proteins, thus giving us the "smoking gun" that connects the bones to the stones - the bison to the people.
9	Here are the remains of a juvenile bison femoral end and diaphysis in the black mat (point to it). The long-bone had an impact scar on it, suggesting that it was processed for the bone marrow.

10	Represented here are images of the temporally diagnostic artifacts recovered so far from the site. The Clovis point base on the upper left is about 13K yrs old, while the Folsom point fragment below it is about 12K years old. The resharpened Eden point, together with the Scottsbluff point base in the upper right image, are about 11,000 years old and the articulating knife fragments in the center of the image are about 9200 years old.
11	Our soil coring efforts were completed in 2009, 2010 and 2012. The Giddings Coring rig pictured here was brought to the site by geoarchaeologist Vance Holliday and his students from the University of Arizona. From about 50 cores, we recovered dateable bulk sediment samples and pollen samples, as well as bone fragments. Those pictured on the bottom right (point to it) were pulled from 3.7 m below the surface (where the Locus 5 bone bed was eventually defined).
12	The development of this south-to-north stratigraphic cross-section - from Locus 1 on the left to Locus 5 on the right - is based on data from our Giddings cores, the No Name Arroyo (point to it) profiles and six backhoe trenches. The evolution of the landform was controlled by the fluvial erosion of older sediments (such as the Pleistocene sediments in dark gray) that created paleo-channels (seen here and here) (point to them), followed by the delivery of alluvial fan sediments that filled those channels (illustrated by light gray and gold colors). This process was repeated over and over during the late Pleistocene and Holocene. The light gray-colored sediments were repeatedly saturated by the fluctuation of the water table, creating the wet meadow environment which, in turn, became the black mat we see today. These processes were controlled, in turn, by run-off from the Magdalena Mts. in the form of rain and snow-melt.
13	The relatively wet climate that existed between about 11,100 and 8,300 years ago is reflected in this graph, showing the timing of the high stands for various regional lakes, and the Water Canyon wet meadow (point to it). The regional lakes illustrated in this figure include the Estancia Basin and San Augustin Lake (both in NM), Cochise Lake in SE AZ and La Palomas in northern Mexico. The period from about 10,500 to 9,000 cal yr BP seems to have been one of the wettest intervals. After that, there was a net loss of water in all the lakes through about 8,800 BP, although the wetland at Water Canyon persisted until about 8,300 cal yr BP. The more southern lakes reappeared again at various intervals during the Holocene, while the more northern lakes and wetlands did not.
14	So, from our data about the character and chronology of site stratigraphy, we have inferred the dynamics of landform evolution and something of the nature of climatic variability during the late Pleistocene and early Holocene. We have other indicators of moist environments during that time as well, such as the presence of land snails (the *Hawaiia miniscula*), the recovery of *Salienta* (frog and toad) bones, and the discovery of several types of microfossils. We use Microfossil 1, in the top left corner (point to it) to infer hot, wet summers, perhaps even hotter than today, and cold winters, along with ephemeral saturated soils or standing water, which could reflect summer monsoons. This is consistent with models of orbitally-induced changes in solar radiation, where early Holocene summer insolation values were 6-8% greater than modern values, and winter insolation values that were 8-10% lower than modern values. While all three microfossils are extinct, only Microfossil 1 (fingerprint) is known to science. The others are currently unknown.

15	We have a robust pollen record that provides a unique terrestrial perspective for a small slice of the early Holocene with an average resolution of about 100 years between samples. This record derives from 28 samples recovered from three soil cores and three excavation units and is divided into 3 environmental zones. For the period 11,000 - 9300 cal yr BP, Birch pollen suggests the nearby presence of isolated trees growing in wet & shady canyons or around springs. It further indicates a colder and wetter climate during the early Holocene. Pollen Zone 1 (Spore Zone) has a greater diversity of plant taxa than subsequent zones, implying a landscape that was not homogenous, but fragmented into resource-rich mosaics, with greater seasonality in both precipitation and temperature. More interestingly, the Water Canyon pollen data indicate that the early Holocene in west-central NM was a unique environment for which there is NO MODERN ANALOG!
16	From the suite of soil organic matter (SOM) samples recovered for radiocarbon dating, we also derived stable carbon isotope values. These values provide information about the photosynthetic pathways utilized by various plants. As you know, when the "Delta 13 C" values are -20 or less, the environment from which the sample was taken was dominated by C3 plant species. When the "Delta 13 C" values are greater than -20, the environment was dominated more by C4 species. These plant signatures represent a proxy for climate, where C3 species reflect cooler and moister environments and C4 species reflect warmer and drier environments. So, using the stable carbon isotope values, the trend from the late Pleistocene into the middle Holocene was from cooler and moister to warmer and drier – a trend which is supported by the WC pollen profile.
17	So we can use the pollen and stratigraphic records, the microfossil and isotope data, and the inferred paleo-hydrology to reconstruct the late Pleistocene setting at Water Canyon: There, a wet climate with 55-60 cm of annual precipitation led to heavy rain and/or snow fall on the Magdalena Mts. which, in turn, underwrote the existence of a very high water table. As a consequence, the site contained standing water and wet meadows, which attracted bison and the occasional group of Paleoindian hunter-gatherers. The earliest pollen spectra from the Water Canyon black mat indicates a late Pleistocene / early Holocene characterized by strong seasonality with hot, wet summers and cold and perhaps dry winters. This view is consistent with models of orbitally-induced changes in solar radiation, which retrodict early Holocene summer solar insolation values at 30° N latitude 6-8% times greater than modern, and winter insolation values 8-10% lower. One of the pollen types in the record is very degraded, but compares well to cherry (*Prunus*). Scrubby shrubs of cherry may have grown in drier sites around the meadows. Birch pollen is also present, but the representation is too low to represent on-site trees or bog birch shrubs. Isolated birches probably grew nearby in the mountains along wet and shady canyons or around springs. Sage (*Artemisia*) pollen is well-represented throughout the early Holocene at Water Canyon similar to other regional pollen records. This Late Pleistocene sage signature has typically been inferred to reflect a sagebrush steppe. However, sage pollen is not identifiable to species and a variety of non-woody *Artemisia* herbs grow in meadow and grassland habitats. The best interpretation of the Water Canyon sage is that it represents herb species given the sampled meadow context. Evidence from packrat midden series to the south may support this theory. Macrobotanical sage remains identified from these middens are either herbaceous (*Artemisia ludoviciana*) or small shrubs (*Artemisia bigelovii*) with a less definitive category that would include big sagebrush (*Artemisia bigelovii/tridentata*) (Holmgren 2005; Holmgren et al. 2006).

18	As the late Pleistocene transitioned into the early Holocene ca. 9800 BP (as indicated by Pollen Zone 2/ Marshelder Zone), the climate shifted to warmer and drier conditions and the Water Canyon meadow began to shrink. Standing water would probably have been found there only seasonally. This is the period when pollen diversity plummets, and wetter indicators such as birch, the possible cherry, and the microfossils disappear or drop to trace amounts. At about 9300 BP, Cheno-am pollen spikes defining the Cheno-am Zone or Pollen Zone 3, which also corresponds with the steady increase in C4 plant species from the soil isotope data. The Cheno-am rise is a regional, though poorly dated, signature found in southern Arizona, the nearby San Agustin paleo lake record and packrat middens from southwestern New Mexico. The signature probably reflects the expansion of saltbush (*Atriplex*), the xeric and salt tolerant shrub found throughout the Southwest.
19	By the present, we have the Water Canyon site – at 1760 m above sea level - characterized by a juniper savannah community and a water table more than 100 ft below the surface. This open juniper savannah relies on about 15-20 cm of annual moisture for its existence and this, of course, stands in stark contrast to the climate & vegetational community inferred for the site during the late Pleistocene - early Holocene.
20	In conclusion, I would like to thank all the individuals and organizations that have contributed to 5 years of research at Water Canyon, and - for all those attending this presentation today - thank-you for your attention.