Preliminary Analysis of Playa Bedforms of the Black Rock Desert, Washoe County, Nevada

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31 July 2000

The Black Rock Playa

The playa complex of the Black Rock Desert is situated within a broad depositional basin formed by a number of steeply-faulted and uplifted mountain ranges in northwestern Nevada. The playa occupies one of seven distinct basins once filled by pluvial Lake Lahontan; modern remnants of the once vast (8,665 square miles) lake include Pyramid and Walker Lakes (Benson et al. 1990; Grayson 1993). The Pyramid and Walker Lake basins are fed by river systems that originate in the highlands of the Sierra Nevada. These rivers provide a perennial water supply the helps maintain large desert lakes. The basin of the Black Rock Desert is distinctly different.

The most striking landform of the Black Rock Desert is the extensive level playa northeast of Gerlach, Nevada. There are actually two playas in the area: the uplifted and incised playa of the Quinn River or "east arm", and the generally broad open playa of the "west arm". Although both are formed on the desiccated lakebed of pluvial Lake Lahontan and share many characteristics, the open playa of the "west arm" is the focus of the current study. Playa landforms are common in the northwestern Great Basin, but the Black Rock playa is distinct for its size as well as for the organization of its associated landforms. Landforms of the Black Rock playa and its margins include broad alluvial fans, aeolian dunes of several types, prominent fault scarps, spring mounds, and broad, distributary drainage systems.

The Black Rock playa is the modern terminus of the Quinn River. The Quinn cuts through the slightly uplifted section of the east arm and seasonally inundates a portion of the west arm's open playa. Unlike other basins associated with pluvial Lake Lahontan, the Black Rock Desert and the Quinn River receive water input from the north central Great Basin, not the Sierra Nevada. The extent of the ephemeral playa lake depends on local and regional climate patterning, especially the winter precipitation patterns of southern Idaho and north central Nevada. Although climatic disparities between the Sierra Nevada and the northern Great Basin can be significant; the strength of the recent El Niño cycle produced similar high precipitation regimes in both areas. As the regional influence of the El Niño climatic event decreased during the past year, streamflow in the Quinn River and input to the playa lake has similarly decreased.

A Preliminary Study of Playa "Dunes"

With the recession of the seasonal playa lake in the spring/summer of 2000, a complex group of bedforms, often described as low-relief dunes, was observed on the open playa of the east arm of the Black Rock Desert. The bedforms caught the attention of recreational users and regulatory agencies because they are a potential danger to popular cross-playa travel (Delores Cates, Bureau of Land Management, personal communication, 2000). The "dunes" typically range from two to twenty centimeters in height and occur singly covering less than 1 square meter or as complex features over 100 square meters in extent.

Preliminary analysis initiated in the summer of 2000 revealed that the low relief features are complex bedforms influenced by a combination aeolian (wind-driven) processes associated with the

prevailing southwesterly wind and the lacustrine (lake or water-driven) processes of the ephemeral playa lake at the terminus of the Quinn River. In simple terms, the bedforms may be considered dunes; however, their formation is more complex than the term "dune" allows.

The bedforms present on the Black Rock playa are composed of coalesced silt and clay particles (less than 0.05 mm in size) derived from the sediments of the playa. The cohesive nature of the minerals that make up the silt and clay allow the particles to form individual sand-sized pellets (typically greater than 0.25 mm in size, or visible to the naked eye). Particle cohesion and reworking are common phenomena on lakebeds (and playas) subjected to cyclical wetting and drying. Where wind is the dominant process of sediment transport, large playa-margin silt dunes often form (Bowler 1973; Young 1998). Over time the clasts of coalesced silt that make up the dunes are weathered so that the individual particles are no longer apparent. This results in a dune landform that lacks the common cross-bedded stratigraphy of a classic "sand" dune. Complex silt dunes of historic and prehistoric times are common along the margins of the Black Rock playa (Davis 1980).

The bedforms currently present on the Black Rock playa are distinctly different from common silt dunes. They have well sorted, generally symmetrical sedimentary structures. The sorting of sand-sized grains (coalesced silt and clay particles) shows a distinct coarsening upward (i.e., particle size increases upward through the bedform with the largest particles deposited last). The bedforms rest unconformably on the playa surface; it is possible to trace the modern playa surface below individual bedforms. (There have been suggestions posted on the BLM's Black Rock e-mail mailing list that these features may be the result of tectonic deformation, frost- or salt-heaving, or other subsurface processes. The unconformable position of the bedforms shows that they are a result of surface processes.) Individual bedforms also show the regular polygonal cracking associated with the wetting and drying of the lakebed. This suggests that the bedforms have been wet since their deposition.

The general morphology of the bedforms suggests that they were likely formed beneath the waters of the shallow playa lake that covered portions of the basin early this year. The distinct particle sorting, their general distribution, and desiccation cracking point toward a lacustrine or lakebed origin. Wind action on the surface of the shallow lake influenced the pattern of bedform deposition, and the general fluid dynamics of both wind and water acted to form the "dune"-like features. The seasonal lake that forms at the end of the Quinn River system is subjected to the vagaries of seasonal storms and wind direction. The shallow lake, moved by the winds of an approaching storm, can easily shift to cover a new portion of the playa.

Sediment Budget and the Black Rock Playa

The formation of the "dunes" is a product of sediment budget and the intensity of local geomorphic processes. Sediment budget refers to the amount of sediment available for transport or reworking within a given system. Geomorphic processes include wind and water action that result in the transport and reworking of the sediment. I have outlined the possible geomorphic processes of the playa lake in the bedform descriptions above. A look at natural and cultural influences on sediment budget provides possible explanations for the formation of the "dunes".

Sediment budget can be increased by sediment input associated with stream systems and by wind-blown particles. Sediment budget can also increase when a stable surface is disturbed by natural or cultural processes. Reductions in sediment budget occur during periods of erosion that remove sediment from the local system. They can also occur when natural processes cement or cover sediment previously available for reworking.

Much of the sediment of the open playa of the Black Rock Desert was deposited beneath the waters of pluvial Lake Lahontan. The sediments of the lakebed, which forms the modern playa surface, consist of silts and clays with strong cohesive forces. However, the sediment available for reworking is seasonally increased as drying results in the cracking and weathering of the playa surface. Wind reworks the fine particles as clay films or curls are removed from the polygonal structures and cracks. This often results in significant dust transport in the early summer as fine particles are worked into the air. The available sediment is often depleted during the dry season resulting in a stable playa surface (Lancaster 1978). The cycle continues with the next seasonal wetting episode. The vast surface of the Black Rock playa formed under this type of seasonal condition.

The intensity of socio-economic and recreational uses of the lakebed also plays a role in the sediment budget of the playa landform. Large-scale events, as well as cumulative effects of overall increased popularity of desert travel, result in an increase in sediment budget. Most of the increase results from vehicles traveling on the playa, an activity that breaks up the cohesive nature of the playa surface.

People have used the Black Rock playa for hundreds of years, and the Quinn River has been depositing and reworking sediments for much longer. Mapped "roads", even historical trails, mark travel ways commonly used by people of the region. The "dunes" on the open playa, however, have not been noted in the past. Conversations with personnel at the Bureau of Land Management, regional residents, and experienced colleagues suggest that the current and historical expression of the "dunes" is unique. My personal research on the surface stratigraphy of the Black Rock Desert, Quinn River, and its tributaries has found no evidence for prehistoric occurrence of these features. Their morphology, however, makes it unlikely that these features were commonly preserved in the stratigraphic or surface record.

Climatic cycles, including El Niño events, were common throughout the nineteenth and twentieth centuries, and the hydrological input of the Quinn River varied in response to regional climate. Historical human use of the playa included the establishment of several popular travel ways such as the roads to Soldier Meadows, Black Rock Springs, Trego Hot Springs, and Cholona. Under the natural climatic cycle and the common human use of the playa, the sediment budget remained in general equilibrium. Sediment input and disturbance of each season resulted in the reworking of the playa surface and general maintenance of playa conditions. (Davis [1980] reports on prehistoric climatic and hydrologic cycles that resulted in significant reworking of the playa surface and development of the Trego dune field).

The 1990s witnessed an increase in the large-scale use and general popularity of the Black Rock playa. In 1997, two teams pursued supersonic speeds and the land speed record using rocket-assisted "cars". Successive trial and timed runs resulted in the direct disturbance of a large portion of the playa surface. Observers noted that with each run the cars produced linear scars several centimeters deep. In 1990 the Burning Man event had relatively humble beginnings on the east margin of the open playa. By the end of the decade the annual event had grown to include over 20,000 people. The event and its associated vehicle traffic have moved to a new playa location each year.

It is likely that the socio-cultural record of the Black Rock playa is most significant in explaining the presence of the playa "dunes". The increased use of the playa resulted in a concurrent increase in sediment budget due primarily to vehicle traffic associated with large-scale events. The previous playa equilibrium was affected as the sediment budget crossed a threshold where seasonal reworking could not reestablish open playa conditions. A recent increase in sediment load in the seasonal playa lake resulted in bedform formation. The playa system is moving toward a new equilibrium associated with the new sediment budget by establishing "dunes" on the open playa.

References Cited

Benson, L. V., D. R. Currey, R. I. Dorn, K. R. Lajoie, C. G. Oviatt, S. W. Robinson, G. I. Smith and S. Stine

1990 Chronology of expansion and contraction of four Great Basin lake systems during the past 35,000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology* 78:241-286.

Bowler, J. M.

1973 Clay dunes: Their occurrence, formation, and environmental significance. *Earth Science Review* 9:315-338.

Davis, J. O.

1980 Geology of 26Pe118. In *The Archaeology of Trego Hot Springs: 26Pe118*, edited by S. M. Seck. Unpublished Master's thesis, University of Nevada, Reno.

Grayson, D. K.

1993 The Desert's Past: A Natural Prehistory of the Great Basin. Smithsonian Institution Press, Washington.

Lancaster, N. I.

1978 The pans of the southern Kalahari, Botswana. *Geographic Journal* 144:81-98.

Young, D. C., Jr.

1998 *Late Holocene landscapes and prehistoric land use in Warner Valley, Oregon*. Unpublished Ph.D. dissertation, University of Nevada, Reno.