The Vore Site As "Weather Station"

By Gene Gade

A surprising and enormously valuable discovery was made during the original survey excavations of the Vore Buffalo Jump sinkhole in the 1970's. In addition to the site's now-renowned mass of beautifully preserved bison bones and cultural artifacts, scientists found about eight vertical feet of beautifully banded sediments. These colorful, thin layers of clay and silt make possible an amazingly precise dating of many events at the site and a powerful tool for analyzing the climate and ecology of the period when the Vore sinkhole was used as a bison trap.

Breadth and Depth

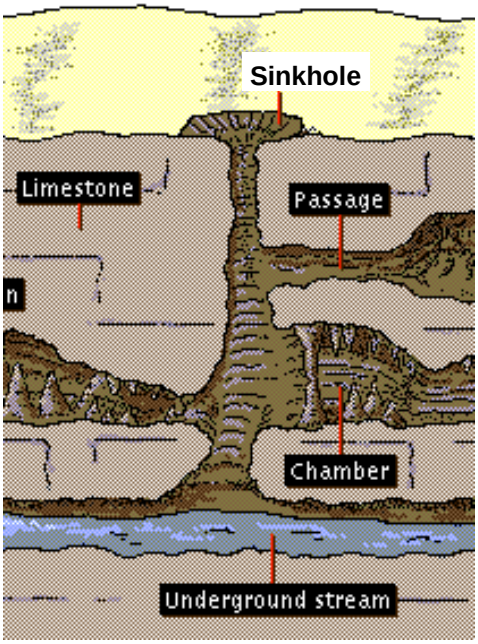
A major goal of the original excavations was to determine both the lateral and vertical extent of the bone and artifact beds. To make the horizontal determination, the archaeologists made an "X-shaped" excavation across the site, north to south and east to west. Those horizontal units established that the bone and cultural material extends all the way across the floor of the sinkhole.

The crew also made a square shaft (3 meters on a side) from the surface to what is believed to be the deepest (and therefore, oldest) bone bed. That vertical unit reached a depth of over 20 feet and exposed many layers of bone.

The upper, younger layers of the Vore excavation units contained amazing quantities of mostly jumbled bison bones, cobble rocks and silt. However, as the archaeologists dug deeper, the amount of bone diminished somewhat and there were gaps, presumably representing periods of years when there was sediment but little bone. At 3.6 meter (@ 12') depth the "laminated sediments" (that is, alternating bands of red silt and gypsum gravel separated by very thin bands of light colored clay) began to appear. (The evidence indicates that each of these couplets (red silt and gray clay), represent one year of sediment deposition in the sinkhole.

Legacy of an Ephemeral Pond

Scientists believe that, for a couple hundred years, a shallow pond occupied the floor of the Vore sinkhole seasonally. When the snow melted and/or the spring/summer rains came, water would flow into the sinkhole, carrying red mud and gypsum with it. Most of this sediment would settle out, forming reddish layers of varying thickness on the bottom of the pond. However, some of the tiny clay particles were small enough to remain suspended in the water as the pond froze over in the fall and winter. When the ice melted in the spring, this trapped whitish clay would slowly sift down, forming a layer that, while very thin, was sufficiently visible to separate sediments deposited in different years. Geologists call these annual layers of sediment "varves." **(Continued on Next Page)**



What's a "Sinkhole" ?

Limestone layers beneath the ground sometimes dissolve away, leaving a "solution cavern." Occasionally, the cavern roof collapses, forming a "sinkhole" at the surface. The underlying cave may be small or enormous. Likewise, the connection from the surface sinkhole to the cave may be larger or narrow and constricted. Sometimes the connection gets plugged with rock and sediment.

Geologically, the Vore site is a sinkhole. There are at least two strata beneath the surface sediments of the Vore site that are capable of forming such caverns. There are many other sinkholes in the area, but it is not clear whether the solution feature beneath the Vore site is a single, large cavern or whether there are many small caves in the region. It is also unknown whether the Vore sinkhole is connected underground to others.

Varves and Tree Rings

Varves -- the alternating red silt/gray clay couplets -- are in many ways analogous to "tree rings" in the stems of woody plants in temperate climates. In tree and shrub stem cross-sections, the lighter bands consist of larger and more numerous cells that are formed in the rapid growth period of spring and early summer. As growth slows down in the late-summer and fall, the cells are smaller and more densely packed, creating the thinner, darker-appearing ring. In tree rings, as in varves, each couplet represents one year.

Moreover, both varves and tree rings can be used as indirect indicators of rainfall. Just as tree rings tend to be thicker in wet years and close together in dry years, the amount of sediment deposited in a varve also tends to be greater when precipitation is abundant and/or frequent. According to Dr. Reher, *"...for all intents and purposes, the sink is a rain gauge 30 meters across."*

Since the Vore site varves are about the same age as the oldest trees in the Black Hills region, it's possible to correlate the regional tree rings with the varves, providing extremely precise dates for some events at the buffalo jump and another line of evidence about climate patterns.

There is an especially good sequence of 282 sediment laminations which would represent 141 years at the Vore site. Comparing them with tree rings, Dr. Reher concluded that this sequence represents the period between 1500 A.D. and about 1641. (After this time, for unknown reasons, the pond, and, therefore, the varves, are not consistently present) .

Finally, the weather patterns and dates documented in the varves and tree rings can be correlated with bison kills at the Vore site. (See graph below) When Dr. Reher made these comparisons, interesting patterns emerged.

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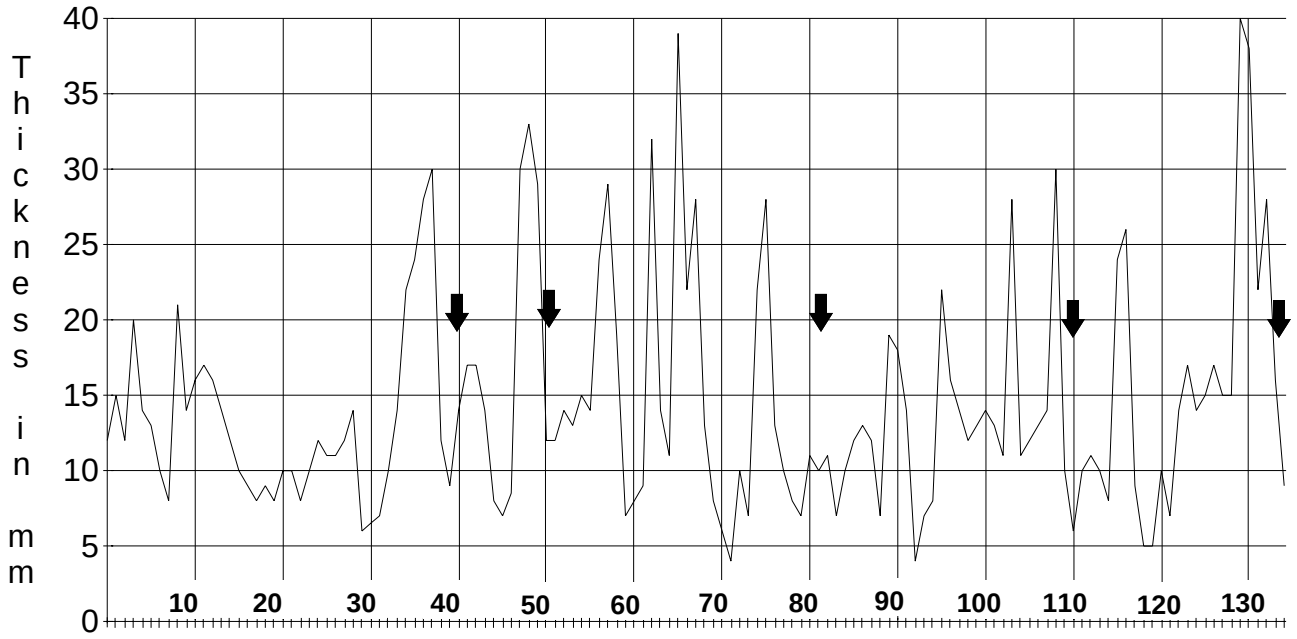
Four out of the first five kills at the Vore site occurred within four years of a peak in precipitation. There was an average of 25 years between these kills and a range of 11 to 34 years between these early hunts at the Vore site. Dr. Reher postulates that each peak in precipitation resulted in an increase in available forage for bison. As their food supply increased in quantity and quality, bison would be attracted to the area and their reproductive success would improve. Usually a per-

Vore Buffalo Jump

Varve Thickness



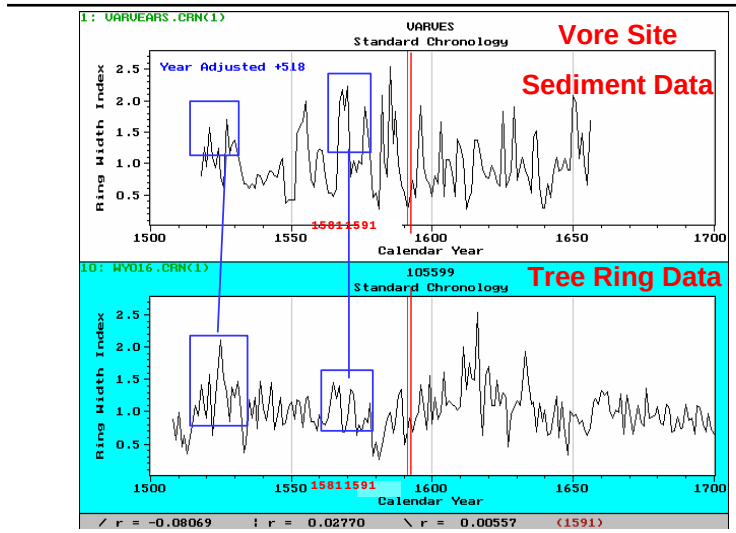
iod of higher precipitation would last several years and result in good bison calf crops. It takes a female buffalo calf three to four years to mature and produce its own first calf.

Thus, about 4 years after the onset of a wet cycle, the calves of the buffalo cows that began the population increase would be joined by the calves of the young cows that were born at the start of the cycle, and the bison population of the region would reach its maximum. The Indians clearly took advantage of this bison population buildup by conducting communal hunts at the Vore site, usually four years after a peak in precipitation.

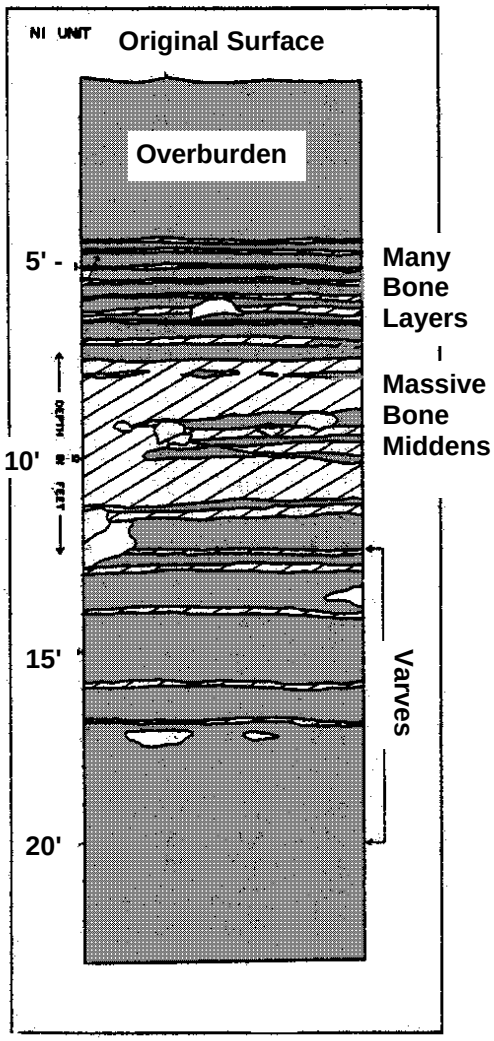
The Little Ice Age

Beginning at least as early as 1350 A.D. and ending about 1900 A.D., much of the Northern Hemisphere experienced a general cooling of its climate. Precipitation apparently also increased somewhat. The most severely cold period was between about 1550 and 1850, a time span that encompasses the use of the Vore Buffalo Jump. This period is often referred to as "The Little Ice Age."

There are many pieces of "scientific" evidence, including tree rings, pollen analysis in bogs and sediments, ice cores from glaciers, etc., that document this climatic shift in both North America and Europe. How and to what degree this colder period and higher precipitation affected Native Americans will no doubt remain a subject of conjecture. Things like tribal migrations are likely to have been influenced by many variables, but it's not unreasonable to ask whether a significant climate change might be one factor. The archaeological evidence is that the Vore site was used with increasing frequency and effectiveness during the 1700's in the height of the Little Ice Age. Dr. Reher states, *"An increasing frequency of kill operations thus documents more regular and larger congregations of social groups, and eventually more elaborate social mechanisms...In such fashion we see one direct deterministic effect of the shortgrass environment on the culture of Plains Indians"* **(Continued next page)**



Vore Site Sediments Have Similar Patterns To Tree Rings



Profile Schematic

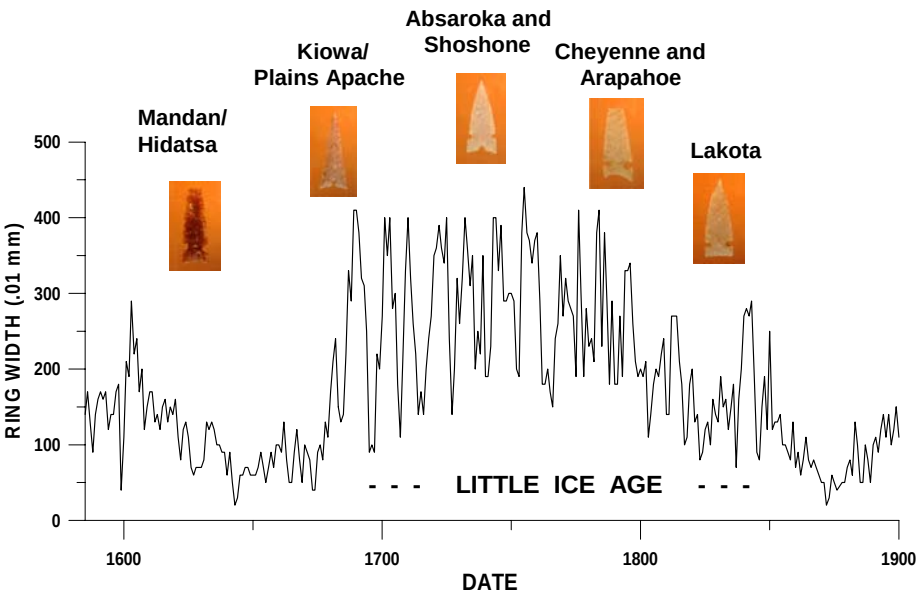
The diagram above represents the vertical profile of the Vore site excavation unit that exposed the varves. The darker shaded areas represent sediments with no bison bone. The areas with diagonal hash marks are the bone middens. White spots are rocks. Note that only 5 bone layers occurred during the varve period, but frequency of site use increased during the last century of use, including a couple of massive bone beds that clearly represent especially productive hunts.

Varves and tree rings are correlated in the graphs at left. Note the similar patterns for the first century and a half of Vore site use.

It is also clear, given the assemblage of stone artifacts from the Vore site and many other lines of evidence, that a number of different tribal groups spent time in the area and used the Vore Buffalo Jump during the period. For example, it is known that the Kiowa and Plains Apache groups moved from the north and west during the period of Vore site use and that they spent at least 100 years in the Black Hills area before moving on to the southern Plains. Arrow points like those fashioned by Shoshone are found at various levels at the site. There is increasing evidence that Middle Missouri tribes or their ancestors used the area and, possibly, the VBJ. Crow, Cheyenne and Arapahoe groups probably left their stone calling cards at the site during the 1700's, and the Lakota were moving into the area about the time use of the site ended. The stone artifacts aid in sorting out who used the site and when, and how they were moving around. Helping to explain how Plains Indian cultures developed and what influenced the changes are among the fascinating rewards that flow from the scientific study of the Vore Buffalo Jump.

(Primary source: Reher, Charles A. and George Frison. 1980. The Vore site, 48CK302, a stratified buffalo jump in the Wyoming Black Hills. *Plains Anthropologist Memoir* No. **19**: 53-59.

The chart at right shows the clear increase in precipitation that accompanied the so-called Little Ice Age in the northern Great Plains - Black Hills region. The projectile points are among those excavated from the Vore Buffalo Jump during the original excavations of the 1970's. While association of particular points with particular tribes is tenuous at best, analysis of point styles, sources of stone and other circumstantial evidence can lead to some reasonable inferences about tribal affiliations.



Europe and the American Colonies in the little ice age

The Little Ice Age is documented in many fascinating ways. For example, there are records that glaciers advanced in the Swiss Alps, engulfing entire farms and villages. The Thames River and the canals and rivers in the Netherlands often froze over so that people skated and held ice fairs on them. In 1780, New York harbor froze solid, allowing people to walk from Manhattan to Staten Island. The suffering of the Continental Army at Valley Forge and other similar incidents of the American Revolution occurred during the Little Ice Age. Oil paintings, journals, essays and even poetry from the period prove that winters were generally more severe during that period than they have been since.

In Europe, the growing season shortened about 15 to 20%, and climate zones shifted about 350 miles south. Pines started to replace oaks and other deciduous trees. (One author even postulates that the exceptional tone qualities of Stradivarius violins is due to the use of denser wood produced as a result of the Little Ice Age.)

Records from France, Switzerland, Germany, Norway, Scotland and England all indicate major declines in agricultural production, sometimes resulting in severe famine and increasing susceptibility to diseases like influenza and Bubonic Plague. Vineyards, which had been established as far north as England in Medieval times, were especially hard hit. Wine production was down as much as 80%! In Norway, many northern and upland farms were unusable . The Viking colonies in Greenland had to be abandoned. During the winters, sea ice extended many miles in every direction from Iceland such that major harbors were blocked. Cod fish moved farther north, devastating the fisheries in parts of Scotland.