Geological/ Paleontological Review
August 2002

Hanford Reach National Monument

Introduction

Geologic history with spectacular landscapes exhibiting the power of nature are a contributing element in the establishment of the Monument. Late Cenozoic tectonic, volcanic and hydrological events in the Columbia Basin resulted in a sequence of interbedded volcanic and sedimentary units showing evidence of shifting channels and disconnecting drainages. Volcanic episodes, such as the Columbia River Basalt flows in the Miocene and the cataclysmic floods associated with the Pleistocene Ice Age, define the topographic features of the Monument. Rattlesnake Ridge and the Saddle Mountains, two prominent, high elevation features in the Monument, were formed from the Columbia Basalt Group dating from 6 to 17 million years ago.

Several unique features are found on the Monument. For example, the world-renowned bedrock basalt flows have ridge features (known as "wrinkle ridges") analogous to those on Mars and possibly in other portions of the solar system. Subsequently, Ice Age flood depositional features both covered and exposed these basalt flows. The Pasco Basin, which is surrounded and encompassed by the Monument, subsided as a result of the basalt flows in the late Miocene and became the receptacle for fluvial and wind- blown (loess) deposits.

A series of cataclysmic floods occurred between 12,500 and 15,000 years ago during advances and retreats of the glacial lobes in northern Washington and Canada. Both erosional and depositional features were created as the floods entered the Columbia Plateau. To the north of the Monument are the channeled scablands, so named for the resistant basalt ridges remaining after the flood waters stripped out large quantities of softer sediment such as loess and sand. Massive quantities of sand and gravel were transported into the Pasco Basin in a short time frame of perhaps only a few days. The process was repeated several dozen times during the Pleistocene. Glacial erratics (large boulders of non-local rock such as granite from Idaho), were carried in by the raging waters are scattered around the Monument, such as the flanks of Rattlesnake Mountain. A major lake, known as Lake Lewis, formed in the Pasco Basin behind resistant basalt at Wallula, southeast of Pasco. It is estimated to have been about 4500 square miles in size. The highest lake level is estimated to be about 1200' elevation which corresponds to the 1200' road near the toe of Rattlesnake Mountain. The depth of the lake was about 900 feet.

Other unique features connected to the floods are bergmounds, giant ripple marks and gravel bars. All of these features are considered slack water deposits which occur when the turbulent water action subsides. The southwestern end of the Monument, near the McGee/Riverlands and ALE Units, contains such topographic high points since the northern base of Rattlesnake Mountain was the periphery of the lake. Erratics and bergmounds were left when icebergs rafted lithic material from other areas then deposited them as the ice melted and the lake withdrew.

Erratics consist of non-indigenous rock chunks such as granitics, gneiss, quartzite, argillite and schist and may be large boulder-sized. They are found up to the highest lake levels, about 1200' in elevation on Rattlesnake. Bergmounds typically form a mound with smaller gravels composed of these same materials but are found at slightly lower elevations, usually below 1000'. It is believed that bergmounds were formed when larger icebergs grounded themselves at the shallow edges of the lake. Being larger and deeper they hit bottom sooner than those carrying the erratic boulders and melted in place with their gravel loads.

One of the major landmarks within the Monument, the White Bluffs, is the middle component of the Ringold Formation, which dates between 3 and 8 million years ago. The formation is composed of a 300m thick deposit of interbedded lacustrine and fluvial silts, sands and conglomerate with some paleosol remnants. The source of the sediments is thought to be either the Clearwater/Salmon drainage system from Idaho or an ancestral Columbia River. Regional uplifting about three million years ago resulted in the present upper Columbia River down cutting through about 600 feet of the Ringold Formation to its present elevation of 100 meters. Most noteworthy is the vertebrate and invertebrate fossils which have been found within the Ringold. The lowest River Road component of the formation has yielded rhinoceros and anadromous salmon from the late Miocene. The subsequent White Bluffs component contains more fossils:27 species of mammals alone. Some of the fauna noted include rodent, lizard, frog, turtle, fish, rabbit, bear, canid, cat, ground sloth, peccary, deer, mastodon, camel, horse and zebra. Of particular interest is the nature of the fish--which are primarily warmer water species, such as catfish and sunfish-- supporting the theory of two separate drainage systems during the Miocene. At that time the drainage system responsible for the White Bluffs deposit may not have been connected to the Pacific Ocean, hence the lack of anadromous fish remains.

The Recent Age of the Holocene Epoch topographic features consist primarily of sand dunes located in various parts of the Monument. The most notable dune field, located in the southeast corner of Central Hanford, was specifically included as part of the Monument in order to protect this unique geological phenomenon. Parabolic dunes are the predominant type, although barchan and transverse dunes appear. Reworked Pleistocene flood deposits provide the sand source for the dunes. Dunes range from 10-16 feet high and can cover several hundred acres. These active, primarily unvegetated, dunes migrate in an east to northeast direction at a rate of 2.5 to 4.5 meters/year. Various other dunes can be identified within the Monument landscape. The top of the White Bluffs have a well-known field with both migrating dunes on the bluff edge and stabilized dunes to the east. Smaller dune areas are located within ALE. Movement and stability varies depending on natural factors (fire, wind, vegetation) and human intervention (surface disturbance). For example, the 2000 fire on ALE denuded the area, reactivating dunes which previously were protected from erosion by vegetative cover.

Current Management

In August of 2002 a review of geological/paleontological resources within the Monument involved regional experts and Monument staff. Contractors from DOE and other researchers in the area provided most of the information. It is clear from the input of the participants that the

Monument contains unique geological and paleontological features that need protection, research and interpretation.

No management program has been developed for geological/paleontological resources on the Monument. The FWS, the DOE and the Bureau of Reclamation are involved with the White Bluffs landslide issue and support the on-going work undertaken by the U.S. Institute for Environmental Conflict Resolution. Other project research has been undertaken by the DOE and its contractors but has been driven primarily by the clean-up process and human safety issues. For example, a several thousand acre exclusion in the ALE unit represents the DOE interest in access to a basalt outcrop for material to cap the Hanford waste sites. No interpretation of the extensive features within the Monument has been done but FWS has participated in geological tours of the area and is supportive of efforts by the NPS to study the possibility of an Ice Age Flood Trail which could encompass part of the Pasco Basin.

Planning Issues

White Bluffs Landslides

This issue is one that cross-cuts all aspects of the Monument. Although exposure of the Ringold formation and fossil localities is a useful aspect of the landslide for geologists and paleontologists the erosion is detrimental. The most prominent and controversial slide is the one above Locke Island. Here flood deposits have filled a paleo river channel nearly two miles wide. The sediments are unconsolidated silts and sands which promote the percolation of water until an impermeable stratum captures the flow and causes it to seep out causing slope instability. Continual hydration has resulted in an estimated slide containing 12 million cubic yards of sediment for the Locke Island slide. The movement of the landslide into the river has caused erosion of cultural sites on Locke Island and siltation of salmon spawning beds. Sloughing also threatens the rare White Bluffs bladderpod. Another large (10 million cubic yards) slide, known as the Savage Island slide, is apparent near Ringold. Public use of the area also raises not only issues of protection of the resources but public safety concerns as well. Smaller landslides, some as recent as the mid-1990's are also occurring.

Development

Oil and gas leases exist adjacent to the Monument. Future development and expansion of these explorations could lead to industrial complexes that would alter the viewshed and/or lead to environmental impacts or threats to protected habitat as the result of pipelines and other construction.

Increased public use may especially threaten fossil and petrified wood deposits in the White Bluffs and Saddle Mountains. Although collection on the Monument is prohibited, additional use brings the potential for increased illegal activity. Additional law enforcement staff would be needed.

Research

Substantial geological study has been, and continues to be, undertaken within the Hanford Site and parts of Monument, including seismic monitoring, flood basalts, paleontological resources and fault trenching. Questions arise concerning who, what, when, how and where research will be conducted within the Monument. Peer and agency review of proposals has been suggested.

Data gaps in paleontological research, especially on invertebrate (plant) fossils and unique flood features such as bergmounds, need to be addressed. Predictive modeling, including correlating old river terraces with archaeological sites, would be useful. Existing geological mapping of the Monument is dated and unreliable. Data retrieval is limited as many studies are project specific and sometimes incomplete or unpublished.

Opportunities

Land acquisition in the Saddle Mountains near Taunton Bench would provide the Monument with a potential public use/interpretive area similar to the White Bluffs. Fossil localities within the Ringold Formation, which terminates on the eastern side of the Saddle Mountains, are exposed. These locales contain more species and are more accessible than those within the Monument.

Interpretation of the many unique features is desirable for increased public use and education. Many partnering opportunities exist to develop such sites. The NPS is currently studying a potential Ice Age Flood Trail in which we could be a part, highlighting our unique depositional features; ripple marks, dunes, and bergmounds. Geological tours for students and public are popular. The Ice Age Flood Institute and Friends of the Pleistocene already have instituted auto tours of features in the Columbia Basin area, portions of which have included the Monument.

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Geological Review
August 6, 2002

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