

Geologic Resources Inventory Workshop Report  
Dinosaur National Monument, CO-UT

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**NPS Inventory and Monitoring Program**

WORKSHOP SUMMARY

An inventory workshop was held at Dinosaur National Monument on August 10-11, 1998 to discuss the monument's geologic resources and associated issues and needs. In all, fifteen cooperators participated in the two day workshop. The list of participants is in Appendix A.

Field Trip

In the morning of the first day of the workshop, Wallace Hansen, who mapped most of the Dinosaur area before retiring from the USGS, led a field trip for many of the cooperators. The group travelled to Harpers Corner to discuss the stratigraphy, structure, and geomorphology of the monument. Along the Harpers Corner road, the group stopped to discuss areas of unstable roadway due to slumps and landslides.

In the afternoon, the field trip visited the Green River District of the monument. ---, DINO Chief of Maintenance, explained stabilization work that will be done along the bank of the Green River near the park entrance, where the river has been actively eroding its cut bank into the road base that was constructed in the Mancos Shale slope. At Cub Creek, where the road crosses the stream, the group discussed the historic channel incision and recent high flows and sedimentation that create numerous problems for road maintenance. The trip ended with a hike from Josey Morris Ranch to Hog Canyon to view and discuss a stream restoration project that was done to benefit the Ute Ladies-Tresses Orchid, a federally listed rare plant. Steve Petersburg explained that the restoration project has raised the local water table in Hog Canyon, which is a relatively short box canyon eroded into the Weber Sandstone. The increased height of the water table and enclosure of cattle has allowed for recovery and thick riparian growth of vegetation on the canyon floor, but has given limited results for increasing the population of the rare orchid, which appears to grow best on periodically disturbed areas.

Workshop Meeting

After introductions by the participants, Bill Dye and Gary Mott of DINO maintenance took the group on a tour of the Dinosaur Quarry Visitor Center to show the extent of the damage caused by movement of the substrate beneath the building. Issues with the visitor center building are discussed in more detail in the Hazards section.

Joe Gregson, I&M geologist/information manager, presented an overview of the NPS I&M Program, the status of the natural resource inventories, and the geological resources inventory.

Bruce Heise, NPS GRD geologist, followed with an overview of the organization of the Natural Resource Stewardship and Science Washington Office, GRD, and the Colorado pilot project.

Dan Chure, park paleontologist, gave the group a tour of the Jurassic quarry and discussed the instability of the exposed Morrison Formation and fossils. Dan also took the group just east of the Quarry Visitor Center to show and discuss unstable mass wasting conditions associated with the historic quarry office that had been constructed by Earl Douglass.

Christine Turner and Fred Peterson, USGS geologists, gave an overview and discussed important results of the Morrison Initiative, which was an intensive, multidisciplinary research project that comprehensively studied the Morrison Formation associated with paleontological sites throughout the west. Much of the Morrison Initiative work was done in NPS units, and Dan Chure played a key role in its success.

After lunch, Ann Elder and Scott Madsen, park museum specialists/paleontologists, gave the group a tour of a new dinosaur quarry site (2 sauropods) located west of the Quarry Visitor Center in the Lower Cretaceous Cedar Mountain Formation that is an important faunal locality for this time period.

Tamara Naumann, park botanist, discussed the association of rare plants with certain geologic strata and geomorphic surfaces. Tamara shared issues about the Ute Ladies-Tresses Orchid, a federally-listed threatened plant, that occurs in the monument with significant populations in Lodore Canyon.

The remainder of the meeting was devoted to discussing the status of geologic and paleontologic mapping at Dinosaur as well as resources that could contribute to a geologic report about the monument.

## Hazards

Several hazards were discussed that affect the monument--especially the maintenance of park roads and buildings. Most of the hazards were associated with slope or substrate instability and mass wasting events.

1. Along the Harpers Corner road, slumps in existing landslide materials (mostly derived from the Jurassic Morrison Formation) create maintenance and traffic hazards in several areas. DINO Maintenance is considering relocating the roadways to the crests of associated ridges to help alleviate the slumping problems.
2. Along the quarry entrance road near the park boundary, the Green River has been actively eroding its cutbank into the road base that was constructed into the Mancos Shale slope. DINO maintenance has a project in work that will fill in the eroded areas and armor the bank with riprap to protect the road for a time. The hazardous location of the road, unstable Mancos badlands above, and Green River erosion below, were discussed. The only permanent solution may be to move the road to the opposite bank of the Green River, which has its own set of engineering and political issues.
3. At Cub Creek where the road crosses the stream, the creek has incised several meters into the older valley fill deposits. Upstream of the road crossing, recent beaver dams may be restoring the riparian zone and arresting the entrenchment, but this spring, high stream flow eroded around the end of a beaver dam and directed the stream against the road embankment. DINO maintenance had to breach the beaver dam to get the stream flowing back into its main channel and through the culvert under the road. Subsequently, DINO maintenance placed riprap to armor the upstream portion of the roadbed, but the stream rapidly silted in upstream of the barrier, indicating that although entrenched, the stream is still moving significant sediment. This problematic area could benefit from a comprehensive study of the hydrology and geomorphology with the goal of restoring the pre-entrenchment channel geometry and fluvial regime.
4. The relocation of the Echo Park campground was discussed. The existing campground is located on the cutbank of the Green River just below its confluence with the Yampa River in the bend of the river around Steamboat Rock. DINO maintenance personnel indicated that tentative plans were to relocate the campground back from the river on the west side of the Pool Creek canyon to take advantage of the tree cover. It was noted that the close proximity of a side canyon and Pool Creek to west-side area has a greater risk for flash floods and debris flows than would a location on the east side of the creek and canyon (where, unfortunately, there is no tree cover).
5. The Quarry Visitor Center has undergone major damage due to expanding, contracting, and shifting substrate beneath the building. Although the quarry face appears to be somewhat stable, the central part of the structure appears to be sinking and significant offsets of several inches to a foot or more are readily apparent in many areas of the building. The obvious floor deformation and tilting of support beams and windows suggest that the structural integrity of the building may be in jeopardy. The site location is on the Morrison Formation which dips about 50 degrees toward the south. The Morrison contains abundant smectitic clays called bentonite, which swell and contract greatly with changes in fluid content. DINO maintenance has isolated plumbing in

the building and kept the roof in good condition to limit the amount of water that can infiltrate under the building, but the deformation continues. Also, DINO maintenance has reinforced the spiral walkway but must also continually monitor the free standing structure for movement. Deformation and ground movement are also readily apparent in the parking lot and sidewalk outside of the building. DINO maintenance has received some engineering review from the Denver Service Center, but a comprehensive engineering study has never been undertaken. The quarry building is considered a historic structure, so approval must be obtained for any architectural modifications. DINO staff expressed the need for major reconstruction of the quarry building, and all of the cooperators concurred. Although building renovation is well outside the scope of the geologic resources inventory, it is recommended that the ongoing deformation of the quarry building and surrounding area should be studied and that a major engineering review to address the structural problems is needed.

6. Without discussing the details, DINO staff noted that similar, but less severe, foundation-movement issues exist at the headquarters building.

7. Although not specifically discussed, a geologic hazards map is needed for park planning and maintenance.

#### Research Needs

1. Tamara Naumann, DINO botanist, discussed the association of rare plants with certain geologic strata and geomorphic surfaces. The Uinta Basin has 30-40 endemic plant species of which 15-20 occur within DINO. Tamara shared issues about the Ute Ladies-Tresses Orchid, a federally-listed threatened plant, that occurs in the monument with significant populations in Lodore Canyon. In the canyon, the rare orchids grow somewhat abundantly and show a strong correlation with geomorphic surfaces formed under the flow regime established by discharge from the Flaming Gorge dam. J.C. Schmidt and Paul Grams (who mapped the geomorphic surfaces in Dinosaurs canyons) of Utah State University assisted with the orchid inventory. A significant issue is that increased flows from Flaming Gorge have been proposed to assist the recovery of endangered fish in the Green River, but the increased flows might endanger the new-found orchid population. Analysis of existing data is in progress, and further research is needed to determine the effect of flooding on the existing surfaces and plants, as well as, how and if higher flows might create new habitat for the orchid in areas such as Brown's Park. The research will assist with the preparation of a mitigation plan that could help both the orchids and fish.

2. During the discussion of the Morrison Initiative and while visiting the Lower Cretaceous dinosaur dig, it was noted that a comprehensive, multidisciplinary study of the Cedar Mountain and correlative formations would give significant understanding of the paleoenvironment of that time period. New research might include detailed sedimentology, stratigraphy, palynology, pedology, as well as invertebrate and floral paleontology. Understanding of the new quarry site in the Cedar Mountain Formation and its fossils would be greatly enhanced by such a study.

3. Although the present quarry preparation facilities are quite good, several problems exist for long term preparation and curation of specimens. The present facility is located in the Quarry Visitor Center with its structural building problems discussed earlier. In addition, specimen storage facilities are inadequate for the ever-growing collection. Working collections are stored

at the quarry site, but others are stored in sheds or the basement of the headquarters building more than 20 miles away. Improperly ventilated storage facilities make working with radioactive specimens (that contribute to the buildup of radon gas) a hazardous task. DINO staff proposed that a new building should be constructed at another, more stable site. The new building would provide infrastructure for collection preparation and curation, scientific research, resource management, as well as inventory and monitoring activities—all under one roof.

4. As mentioned above, a study of the hydrology and geomorphology of Cub Creek in conjunction with planning for a stream restoration project would assist with continual road maintenance problems in that area.

5. Wallace Hansen suggested that two very large juniper trees in Yampa Canyon, that may be record trees measuring 144” and 120” in circumference, should be cored to get their age and a climate record. Trees of this size may be 2000 or more years old. Tamara Naumann agreed to do the project. Wallace also suggested that vandalized rock art could be retouched, and the group concurred.

#### Interpretation

Although specific interpretive issues were not discussed in detail, several resources associated with geology were noted.

1. Christine Turner and Fred Peterson of the USGS are working with other researchers on a comprehensive report for the Morrison Initiative. They think that after completion of the comprehensive scientific report, that a summary report of the important results will be written for DINO and the general public.

2. Christine Turner and Fred Peterson also discussed earlier work for a professional society geologic guidebook and road log that linked Permian formations among various parks and other sites for the Colorado Plateau. Geologic guidebook road logs have also been discussed at other workshops as an overarching interpretive theme among parks.

3. Several interpretive publications related to geology are available for DINO. A comprehensive geologic map of DINO has been compiled and published (Hansen, Rowley, and Carrara, 1983) and is for sale in the monument book stores. A river runners guide (Hansen, 1993), that is published by the Dinosaur Nature Association and that explains the general geology of the monument quite well, is also for sale. A USGS Professional Paper and Rocky Mountain Association of Geologists paper about the Eastern Uinta Mountains (both by Hansen, 1986) are available but not for sale. Other resources by the Untermanns and Don Stone are also available but not sold in the book stores. A generalized geology publication for DINO would make a useful interpretive addition to the existing publications.

## Maps

1. Geologic Maps. Due to the extensive work by Wallace Hansen and his colleagues, the geology of the Dinosaur area has been well-mapped. Fifteen 1:24,000 and several smaller scale maps, including a 1:50,000 scale Dinosaur National Monument map (Hansen, Rowley, and Carrara, 1983), exist for the area. At the subsequent map evaluation meeting at the USGS in Denver, stable-base source maps will be sought for developing a digital geologic coverage for the park. Several in the group had heard about the existence of scanned versions of the DINO maps, but no one knew of their status. Michele Gudorf of the Intermountain Region GIS group was contacted, and only part of the existing map coverage is available and that is probably in an old version of GRASS GIS and will not be useable for the inventory map products. Michele is sending a copy of the data to the I&M Program in Fort Collins for evaluation.

2. Paleontologic Maps. Dan Chure discussed the fact that no complete maps showing the locations of the quarry sites and fossil locations currently exist. Source maps of the Carnegie, Smithsonian, and University of Utah quarry activities are available, and a National Science Foundation grant has been acquired to compile a comprehensive map and database of the fossil attributes and locations. A contractor(?) in Salt Lake City is compiling the map and database of more than 4000 records that document more than 400 fossil animals. A multimedia demonstration project is also in work that will combine photos, drawings, literature, citations, etc. into an interactive visitor display. The Carnegie Museum wants to publish the completed map for sale.

3. GIS Data. The cooperators discussed that some GIS data had been developed for the monument and that other base cartographic data should be available from the I&M Program, the Intermountain Region GIS staff, and Moffat County (DOQQs). The I&M Program has DLG, DEM, DRG, and DOQ data available on CD-ROM, so Moffat will not be contacted. The Intermountain Region GIS staff has the partial geologic raster map(s) and a coarse vegetation coverage available. The geomorphic surfaces coverage may be available from Paul Grams of Utah State University.

4. GIS Needs. DINO does not currently have an operational GIS. Since DINO does not have a FTE to dedicate for a GIS Specialist position, the best alternative is to acquire a desktop GIS system (i.e., Arcview GIS) that the scientific and resource management staff could use to support their research, inventory, and monitoring activities. The I&M and Intermountain Region GIS Programs should be able to assist DINO staff with setting up a GIS system for the park.

## Report

Several geologic reports already exist that cover the DINO area quite well as discussed in 3 under Interpretation above. The consensus of the group was that a synopsis of the existing material could be compiled for the geologic inventory report. Paleontology (Dan Chure), hazards, data, and other sections will be compiled and written by GRD and I&M staff as needed. If the final report is suitable, it may be edited, compiled, and given to the Dinosaur Nature Association for publication and sale. Otherwise, the inventory report will be available over the Worldwide Web, as an MS Word document, and in printed hard copy on request.

## ACTION ITEMS

1. Joe Gregson will check for available digital base cartographic and other GIS data that is available for DINO (DONE, 9/18/98).
2. Obtain stable-base geologic map masters from USGS for digitizing.
3. Digitize, attribute, and develop GIS for DINO geologic maps.
4. Compile, edit, and distribute DINO geologic report.
5. Establish a GIS system for DINO (I&M and IMR will assist with data). DINO staff should propose an Arcview GIS system for funding by the IMR GIS FTSC (Teresa Ely). (\*\*Need to identify at least one DINO NR staffer to take the lead for this desktop GIS.)
6. Geologic hazards map. Check with states of Colorado and Utah for any existing data. Assess feasibility of developing hazards map for park GIS.
7. Abandoned mine lands inventory. Review topographic maps for locations of mine adits and shafts. Develop GIS coverage and AML data records if possible.
8. Develop paleontological themes for park GIS (DINO/USGS/IMR projects).
9. Archive DINO research library materials into NRBIB Procite database. Vince Santucci has contacted Scott Palowski, archivist at Yellowstone N.P. about a detail to assist with this project.
10. Conduct a cave inventory (unique geologic features). Interviews with DINO staff provided information about several caves in the monument. Identified caves include Whispering, Signature, Mantell, Interstate, and Cave of Logs. Copies of reports were forwarded to Ron Kerbo of NPS GRD.

## ANTICIPATED BUDGET

Digitize and Attribute 20 Geologic Maps (@\$1250 est. per map).....	\$25,000
Develop assoc. GIS and deliver all data to park.....	\$ 7,500
Compile, edit, rewrite, existing report information.....	<u>\$ 2,500</u>
Estimated Budget Total.....	\$35,000

## APPENDIX A: WORKSHOP COOPERATORS

Dan Chure, DINO Park Paleontologist  
Ann Elder, DINO Museum Specialist-Paleontologist  
Scott Madsen, DINO Museum Specialist-Paleontologist  
Tamarra Naumann, DINO Botanist  
Steve Petersburg, DINO Resource Management  
, DINO Interpretation  
, DINO Maintenance  
Bill Dye, DINO Maintenance  
Gary Mott, DINO Maintenance  
Joe Gregson, NPS I&M Program  
Bruce Heise, NPS GRD  
Vince Santucci, NPS GRD – FOBU  
Tim Connors, NPS GRD  
Wallace Hansen, USGS (retired)  
Christine Turner, USGS Denver  
Fred Peterson, USGS Denver (Geologists in Parks Program)

## APPENDIX B: WORKSHOP AGENDA

### Dinosaur National Monument Geologic Resources Inventory Workshop September 10-11, 1998

Thursday, September 10, 1998 – Meet at Dinosaur National Monument Headquarters

9:00 AM Field trip in the monument with Wallace Hansen (USGS retired)

Friday, September 11, 1998 – Meet at Quarry Visitor Center

8:30 AM - Welcome and Opening Remarks, Dan Chure, Dinosaur NM

Introductions

Foundation Movement and Hazards Associated with the Quarry Visitor Center  
- Bill Dye, Dinosaur Maintenance

NPS Inventory & Monitoring Program Overview and Geologic Resources Inventory  
- Joe Gregson, NPS I&M Program

NPS Geologic Resources Division Overview and Colorado Pilot Project  
- Bruce Heise, NPS GRD

Quarry Tour and Discussion of Quarry face stability and historical quarry office  
- Dan Chure, DINO

Recent Stratigraphic Work and the Morrison Initiative  
- Christine Turner, USGS and Fred Peterson, Volunteer GIP (USGS Emeritus)

Visit and Discuss Ongoing Lower Cretaceous Dinosaur Dig  
- Ann Elder, DINO and Scott Madsen, DINO

Rare Plants and Associations with Specific Geologic Strata  
- Tamara Naumann, DINO

Geologic Resources Needs and Issues at DINO  
- Park Staff and Cooperators

Deliverables from mapping, cooperators, and geologic resources inventory  
- NPS Staff and Cooperators

## APPENDIX C: OVERVIEW OF GEOLOGIC RESOURCES INVENTORY

The NPS Geologic Inventory is a collaborative effort of the NPS Geologic Resources Division (GRD) and Inventory and Monitoring Program (I&M) with assistance from the U.S. Geological Survey (USGS), American Association of State Geologists (AASG), and numerous individual volunteers and cooperators at NPS units, colleges, and universities.

From the perspective of the servicewide I&M Program, the primary focus (Level 1) of the geological inventory is 1) to assemble a bibliography of associated geological resources for NPS units with significant natural resources, 2) to compile and evaluate a list of existing geologic maps for each unit, 3) to develop digital geologic map products, and 4) to complete a geological report that synthesizes much of the existing geologic knowledge about each park. The emphasis of the inventory is not to routinely initiate new geologic mapping projects, but to aggregate existing information and identify where serious geologic data needs and issues exist in the National Park System.

The NPS Geologic Resources Division is an active participant in the I&M Program and has provided guidance and funding in the development of inventory goals and activities. GRD administers the Abandoned Mine Lands (AML) and Geologists In Parks (GIP) programs which contribute to the inventory. NPS paleontologists, geologists, and other natural resource professionals also contribute to inventory planning and data. A major goal of the collaborative effort is to provide a broad baseline of geologic data and scientific support to assist park managers with earth resource issues that may arise.

For each NPS unit, a cooperative group of geologists and NPS personnel (the Park Team) will be assembled to advise and assist with the inventory. Park Teams will meet at the each NPS unit to discuss and scope the geologic resources and inventory, which is the subject of this report. If needed, a second meeting will be held at a central office to evaluate available geologic maps for digital production. After the two meetings, digital geologic map products and a geologic report will be produced. The report will summarize the geologic inventory activities and basic geology topics for each park unit. Due to the variety of geologic settings throughout the NPS, each report will vary in subject matter covered, and section topics will be adapted as needed to describe the geologic resources of each unit. Whenever possible, the scientific sections of the report will be written by knowledgeable cooperators and peer reviewed for accuracy and validity.