Sequoia and Kings Canyon National Parks

GRI Ancillary Map Information Document

Map Showing Limits of Tahoe Glaciation

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic Data for Sequoia and Kings Canyon National Parks

tagl_glaciology.pdf

Version: 8/14/2013
Table of Contents

Geologic Resources Inventory Map Document................................................................. 1
About the NPS Geologic Resources Inventory Program.................................................. 2
GRI Digital Map and Source Map Citation..................................................................... 4
  Map Units and Feature Class List.................................................................................. 4
Limit of Tahoe Glaciation................................................................................................. 5
  Location Index Map........................................................................................................ 5
  15-minute Quadrangle Index.......................................................................................... 6
  Report.............................................................................................................................. 7
  References..................................................................................................................... 9
GRI Digital Data Credits................................................................................................. 11
Geologic Resources Inventory Map Document

Sequoia and Kings Canyon National Parks,
California

Document to Accompany Digital Geologic-GIS Data

tagl_glaciology.pdf

Version: 8/14/2013

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Sequoia and Kings Canyon National Parks, California (SEKI).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park.
(s), enter “GRI” as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: http://www.nature.nps.gov/geology/inventory, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.
GRI Digital Map and Source Map Citation

The GRI digital glaciologic-GIS map for Sequoia and Kings Canyon National Parks, California (SEKI):

**GRI Digital Map Showing Limits of Tahoe Glaciation in Sequoia and Kings Canyon National Parks, California (GRI MapCode TAGL)**


Map Units and Feature Class List

No geologic units are presented in the digital glaciologic-GIS data produced for Sequoia and Kings Canyon National Parks, California (SEKI). Instead features include limit of Tahoe glaciation and groves of Sierra redwoods.

**Limit of Tahoe Glaciation:** Features show the limits of the Tahoe Glaciation. The map was created by James Moore (USGS) using field evidence, aerial photographs, and topographic maps. Many canyons contain moraines of both Tahoe and Tioga ages. Where juxtaposed, the Tioga moraines lie within, and upstream from, the Tahoe moraines. The boulders of the younger Tioga moraines are less extensively weathered.

**Groves of Sierra Redwoods:** Feature class consist of areas of Sierra redwoods, also called Giant Sequoia (Sequoiadendron Gianteum), from two different sources; NPS generated data and digitized from USGS topographic base map. The data can be identified by the Source attribute.

The NPS generated data is found within Sequoia and Kings Canyon National Parks. The data layer was created by the NPS and supplied by Sequoia and Kings Canyon National Park. In 1979, Doug Walner, Forestry Technician under the direction of Tom Warner, Park Forester, laid out all of the paper maps of individual sequoia locations for each grove. Using a mechanical scaling device, Doug traced around the outermost sequoias in each collection of maps that represented sequoias. The initial groves were digitized in 1995. New groves were added/changed in 1996 to provide more accurate representation of grove boundaries. An additional new grove was discovered and mapped in 1999. In 2002 the Dillonwood Grove was added due to an addition at the southern boundary of the park. This grove was previously mapped by the Sequoia National Forest and it not to the same resolution as the other groves in Sequoia National Park. This feature class is non-standard NPS GIS-Geology geodatabase layer.

The data digitized from the USGS topographic base map and is found within Sequoia National Forest and others lands. All the groves were next to Sequoia and Kings Canyon National Parks. This Giant Sequoia layer was digitized from USGS Sequoia and Kings Canyon National Parks and Vicinity, California (1996) topographic base map, scale 1:125,000. Sierra redwood groves were found on the base map and hand digitized. This feature class is non-standard NPS GIS-Geology geodatabase layer.
Limit of Tahoe Glaciation

Location Index Map

Extracted from: [Tahoe Glaciation](#).
15-minute Quadrangle Index

<table>
<thead>
<tr>
<th>Huntington Lake</th>
<th>Blackcap Mountain</th>
<th>Mount Goddard</th>
<th>Big Pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tehipite Dome</td>
<td>Marion Peak</td>
<td>Mount Pinchot</td>
<td></td>
</tr>
<tr>
<td>Giant Forest</td>
<td>Triple Divide Peak</td>
<td>Mount Whitney</td>
<td>Lone Pine</td>
</tr>
<tr>
<td>Kaweah</td>
<td>Mineral King</td>
<td>Kern Peak</td>
<td>Olancha</td>
</tr>
</tbody>
</table>

PARK AREAS
INTRODUCTION

The latest periods of extensive ice cover in the Sierra Nevada include the Tahoe glaciation followed by the Tioga glaciation, and evidence for these ice ages is widespread in the Sequoia and Kings Canyon National Parks area. However, the timing of the advances and retreats of the glaciers during the periods of glaciation continues to be a matter of debate. A compilation of existing work (Clark and others, 2003) defines the Tioga glaciation at 14-25 thousand years ago and splits the Tahoe glaciation into two stages that range from 42-50 and 140-200 thousand years ago. The extent of the Tahoe ice mass shown in the map area is considered to represent the younger Tahoe stage, 42-50 thousand years ago.

Evidence of glaciations older than the Tahoe is limited in the southern Sierra Nevada. After the Tioga glaciation, only minor events with considerably less ice cover occurred. The Tioga glaciation was slightly less extensive than the Tahoe glaciation, and each covered about half of the area of Sequoia and Kings Canyon National Parks. The Tahoe glaciers extended 500-1,000 ft lower and 0.5-1.2 mi farther down valleys. Evidence for the Tahoe glacial limits is not as robust as that for Tioga, but the extent of the Tahoe ice is mapped because it covered a larger area and the ice did leave prominent moraines (piles of sediment and boulders deposited by glaciers as they melted at their margins) lower on the east front of the range.

Current Sierra redwood (Sequoiadendron giganteum) groves occur in a belt on the west side of the Sierra Nevada, generally west of the area of Tahoe glaciation.

TAHOE GLACIATION
Field evidence, aerial photographs, and topographic maps were used to prepare this map. Many canyons contain moraines of both Tahoe and Tioga ages. Where juxtaposed, the Tioga moraines lie within, and upstream from, the Tahoe moraines. The boulders of the younger Tioga moraines are less extensively weathered.

The preserved moraines were mapped in the 15-minute quadrangles (see index map) that show the geology within the parks (Bateman and Moore, 1965; du Bray and Moore, 1985; Moore, 1963, 1978, 1981; Moore and Sisson, 1985, 1987; Moore and Nokleberg, 1992; Sisson and Moore, 1994; Stone and others, 2000), and they provide the primary evidence for the position of the lower ice margins. At higher elevations where deposition of moraines is limited, glacial polish, glacial striations, transported boulders of different character than their site of deposition (erratics), glacial lakes, and shape of valley walls help fix the position of the upper glacial margins. Aerial photographs and topographic maps were used to relate mapped moraines with characteristic glacial features, such as U-shaped valleys, lakes, and cirques, and to estimate the extent of glacial ice where no morainal deposits remain.

About 2,000 lakes longer than 200 ft occur in the map area. They average about 11,000 ft in elevation, and most lie between 8,000 and 12,500 ft. Nearly all the natural lakes have a glacial origin and occur within the bounds of the Tahoe ice cover. They formed where glacial ice scooped out bedrock basins or dammed canyons and their tributaries with morainal debris. The only natural lakes in the map area that do not have a glacial origin are Kern Lake (6,200 ft elev) in Kern Canyon, which is dammed by a landslide, and Oriole Lake (5,600 ft elev) 5 mi west of Silver City, which also has a landslide origin.

The glaciers occupied five major drainage basins: San Joaquin, Kings, Kaweah, and Kern River drainages on the west slope of the Sierra Nevada and the Owens River drainage on the east Sierra slope. The glaciers covered much of the country above 9,000 ft elevation except for the highest peaks and ridges. Valley glaciers commonly descended to 8,000 ft. In general, the main trunk glaciers of the west flank descended to lower elevations in the north than in the south because of a broader slope and lower temperatures in the north. The lower extents of the glaciers in the San Joaquin river drainage extend beyond the map area. Tahoe glacial terminal elevations of the North, Middle, and South Forks of the Kings River were about 3,800, 4,100, and 4,500 ft, respectively. Termini of the Marble, Middle, East, and South Forks of the Kaweah River were at 6,100, 5,900, 5,100, and 6,200 ft, respectively. The Kern River glacier terminated at 6,300 ft.

Glacier termini on the east slope were at higher elevations because of lower precipitation and smaller drainage basins (Moore, 2000). The glacial deposits are better preserved on the more arid east slope of the range. Also on the east slope, the lower elevation reached by the toes of Tahoe glaciers increases from north to south, from about 6,000 ft to 10,000 ft.

**SIERRA REDWOOD GROVES**

Sierra redwood, or sequoia (Sequoiadendron giganteum), groves are shown on the map, and their location provides an interesting comparison with the extent of the past glacial ice. About three dozen groves occur in a belt on the west side of the range, where they thrive in a zone of restricted elevation and microclimate that generally lies west of the area of Tahoe glacial cover. The source data for groves within the parks is from the National Park Service and for groves outside the parks is from the United States Department of Agriculture Forest Service. The sequoia groves occur at 5,000 to 8,000 ft elevation and, within the mapped area, the average elevation of the trees increases about 1,000 feet from north to south: from 5,000-7,000 ft in the north to 6,000-8,000 feet in the south. Hence, the sequoias, like the glaciers, are affected by the latitudinal effect on climate. Sequoia groves have grown on glaciated terrain in only two places where large glaciers reached low elevations in major canyons: in the canyon of the East Fork of the Kaweah River (Atwell Grove and East Fork Grove) and in and near the canyon of the South Fork of the Kaweah River (South Fork Grove and Garfield Grove).

**SUMMARY**
The mapped Tahoe glaciation, which ended about 42 thousand years ago, covered about half of the parks area. This glacial period was followed by a slightly less extensive ice age, the Tioga glaciation, which ended about 14 thousand years ago. The margins of the Tahoe ice fields, and the lower limits to which the main trunk glaciers descended, occur at progressively higher elevations from north to south, because the average temperature generally increased to the south. The Sierra redwood (Sequoiadendron giganteum) groves occur in a belt immediately west of the area covered by Tahoe glaciation with only minor overlap. The groves, like the much earlier ice, also increase in elevation from north to south, because they, too, are sensitive to climatic variability.

References


Extracted from: (Tahoe Glaciation).
GRI Digital Data Credits

This document was developed and completed by Greg Mack (NPS PWR Seattle) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Stephanie O'Meara (Colorado State University).

The information in this document was compiled from the GRI source map, and intended to accompany the digital glacial-GIS map and other digital data for Sequoia and Kings Canyon National Parks, California (SEKI) developed by Greg Mack (NPS PWR Seattle) (see the Limits of Tahoe Glaciation section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map(s)). Quality control of the GIS data by Stephanie O'Meara.

GRI finalization by Stephanie O'Meara (Colorado State University).

GRI program coordination and scoping provided by Bruce Heise and Tim Connors (NPS GRD, Lakewood, Colorado).