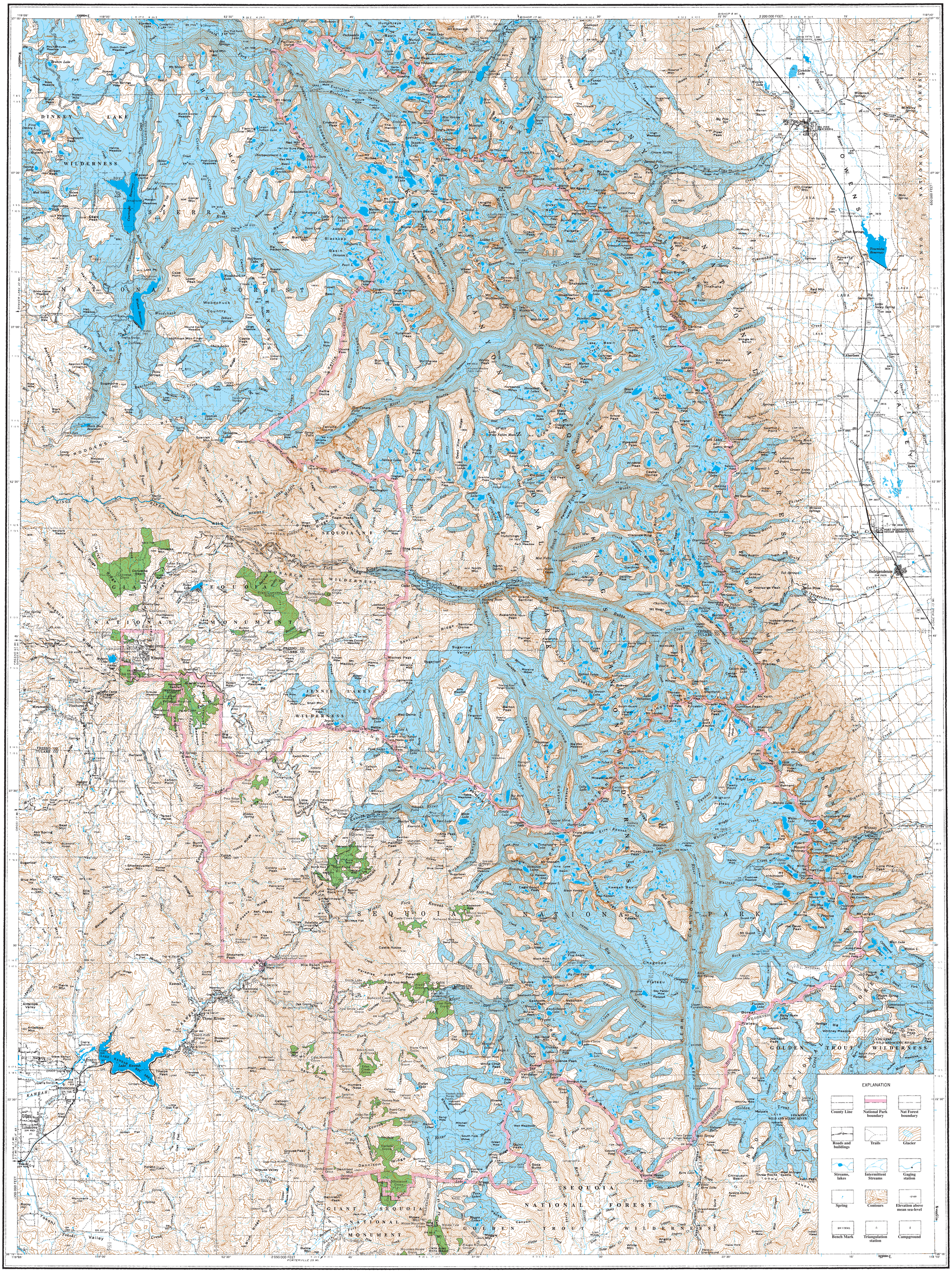
U.S. Department of the Interior
U.S. Geological Survey

Prepared in cooperation with the
National Park Service

Scientific Investigations Map 2945



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 moranial 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.

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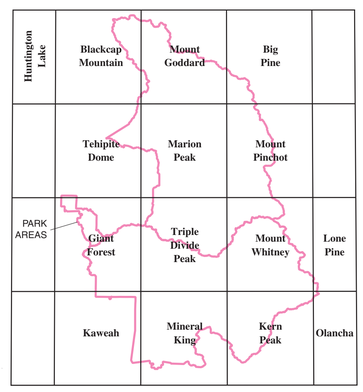
DESCRIPTION OF MAP UNITS

Groves of Sierra redwoods (or Sequoias, *Sequoiadendron giganteum*)

Extent of glacial ice during Tahoe glaciation, 42-50 thousand years ago



Index map showing 15-minute quadrangles for the map area and references for associated published geologic maps.

Big Pine—Not published
Blackcap Mountain—Bateman, 1965
Giant Forest—Sisson and Moore, 1994
Huntington Lake—Bateman and Wones, 1972
Kaweah—Not published
Kern Peak—Moore and Sisson, 1985
Lone Pine—Stone and others, 2000
Marion Peak—Moore, 1978
Mineral King—Not published
Mount Goddard—Bateman and Moore, 1965
Mount Pinchot—Moore, 1963
Mount Whitney—Moore, 1981
Olancha—du Bray and Moore, 1985
Tehipite Dome—Moore and Nockleberg, 1992
Triple Divide Peak—Moore and Sisson, 1987

Base from U.S. Geological Survey, Sequoia and Kings Canyon National Parks and Vicinity, California, 1996

North American Datum of 1927 (NAD 27). Polyconic projection
5000-meter ticks: Universal Tranverse Mercator, zone 11
50,000-foot ticks: California coordinate system of 1983 (zone 4)

North American Datum of 1983 (NAD 83) is shown by dashed corner ticks. The values of the shift between NAD 27 and NAD83 for 7.5-minute intersections are obtainable from National Geodetic Survey NADCON software

Tahoe glaciation mapped by J.G. Moore, 2005
Sierra redwood distribution mapped by Staff of Sequoia and Kings Canyon National Parks, National Park Service
Database by G.S. Mack and J.E. Robinson
Edited by J.L. Zigler
Digital cartography by G.S. Mack, J.E. Robinson, and D.A. Ryan
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Map Showing Limits of Tahoe Glaciation in Sequoia and Kings Canyon National Parks, California

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