MAP GQ-894

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGIC MAP OF THE KAISER PEAK QUADRANGLE CENTRAL SIERRA NEVADA, CALIFORNIA

By
Paul C. Bateman, John P. Lockwood
and Phillip A. Lydon

QUADRANGLE LOCATION

MAP GQ-894

PUBLISHED BY THE U. S. GEOLOGICAL SURVEY
WASHINGTON, D. C.
1971

GEOLOGIC MAP OF THE KAISER PEAK QUADRANGLE CENTRAL SIERRA NEVADA, CALIFORNIA

By

Paul C. Bateman, John P. Lockwood and Phillip A. Lydon

GEOLOGIC HISTORY

Physiographic setting.--The Kaiser Peak quadrangle is representative of the middle elevations of the gentle western slope of the central Sierra Nevada. Most of the quadrangle lies between 6,500 and 9,500 feet, although altitudes are as low as 3,600 feet where the San Joaquin River crosses the west edge of the quadrangle and as high as 11,878 feet on Silver Peak, the highest point along Silver Divide in the northeast corner. Magnificent forests of pine and fir cover the rolling country of these middle elevations, and only Silver Divide and higher parts of Kaiser Ridge, which runs easterly across the quadrangle 2 to 3 miles north of its south boundary, are above timber line and resemble the "High Sierra" of the range crest farther to the east.

Silver Divide and Kaiser Ridge form the boundaries of a broad northwest-trending upland valley that constitutes about three-quarters of the quadrangle. This valley is drained by the San Joaquin River and its tributaries. The South Fork of the San Joaquin is entrenced about 1,500 feet below the general level of the upland valley near the western edge of the quadrangle, but is progressively less deeply entrenched upstream toward the southeast. Entrenched tributaries to the South Fork have thoroughly dissected the upland valley.

The major stream draining the north flank of Kaiser Ridge west of Kaiser Pass is Kaiser Creek, a tributary to the San Joaquin River. The south flank is drained by numerous small streams and by Big Creek, which lies in the Huntington Lake quadrangle immediately to the south and is also a tributary to the San Joaquin River. Big Creek has been dammed to form Huntington Lake, primarily to supply water for the Big Creek hydroelectric plant west of the lake. Additional water is fed into Huntington Lake through a tunnel under Kaiser Ridge from Lake Edison at the east edge of the quadrangle and from Florence Lake, just east of the southeast corner.

Pre-granitic and granitic rocks.--The quadrangle is underlain chiefly by a variety of granitic rocks which were intruded from below as magma (molten rock that commonly contains some crystalline material) during the Cretaceous, Jurassic, and possibly Triassic Periods into still older stratified sedimentary and volcanic rocks. The different bodies of granitic rock shown on the map were intruded at different times, and the period of intrusion spanned many millions of years. Radiometric dating (by rates of atomic disintegration) indicates that the youngest granitic bodies are 80 to 90 million years old (Late Cretaceous), and that the oldest probably are 105 to 120 million years old (Early Cretaceous). However, granitic rocks as old as 210 million years (Triassic) are present farther east, and some rocks in this quadrangle may be this old. The granitic rocks cooled and solidified thousands of feet beneath the surface of the earth, and most of the old stratified rocks which originally covered them have since been eroded away. Nevertheless, remnants of the pre-granitic sedimentary rocks crop out along Kaiser Ridge west of Kaiser Pass, and similar remnants of volcanic rocks form two strips, one along the west side of Silver Divide and the other about a mile north of the west end of Lake Edison.

These old sedimentary and volcanic rocks were originally deposited in nearly horizontal layers but were folded tightly before the granitic rocks were emplaced. The layers were then further deformed and recrystallized by the rising hot granitic magmas, which squeezed the older rocks aside, pushed them upward, and assimilated some of them by melting and by chemical reaction.

The old sedimentary rocks along the Kaiser Ridge were deposited in an ancient sea, along the margins of a landmass. They include quartzite (recrystallized quartz sandstone), marble (recrystallized limestone, calc hornfels (recrystallized calcareous shale and sandstone and shaly and sandy limestone), and pelitic hornfels (recrystallized shale). Calc hornfels is exposed south of Idaho Lake, marble in the vicinity of Twin Lakes, pelitic hornfels near Kaiser Peak, and quartzite west of Kaiser Peak and at the west edge of the quadrangle near Nellie Lake. The marble is a coarsely crystalline aggregate of white calcite, and the quartzite exhibits well-preserved crossbeds of the kind that are formed by near-shore ocean currents.

The remnants of old volcanic rocks in the northeastern and eastern parts of the quadrangle are streaked in shades of light to dark gray. Originally they were beds of volcanic ash (or tuff) that probably erupted from vents in the Ritter Range area to the north and fell or was carried by streams into an ancient ocean. Subsequently, they were compacted and recrystallized to metavolcanic tuff as a result of heat and pressure that accompanied regional deformation and intrusion of the granitic rocks. These volcanic rocks are not in contact with the old sedimentary rocks within the boundaries of the quadrangle, but relations in nearby parts of the Sierra Nevada indicate that the volcanic rocks are younger than and were deposited on the sedimentary rocks.

The granitic rocks shown on the map can be distinguished from one another by differences in grain size, texture, structure, and proportions of constituent minerals. The contacts between individual bodies of granitic rock are sharp, and the relative ages of the bodies can be determined where dikes of a younger rock penetrate an older rock or where detached blocks of an older rock are enclosed in a younger rock.

The granitic rocks belong to three broad groups: one in the northeast corner of the quadrangle, one in the southwest part of the quadrangle, and one which underlies the broad dissected valley and extends southward across the Kaiser Ridge east of Kaiser Pass. The three groups of granitic rocks are discontinuously separated from one another by strips of the old sedimentary and volcanic rocks.

The granitic rocks of the central group intrude those of both the northeast and the southwest groups and are therefore younger, but the relative ages of the northeast and southwest groups are not known. By far the most extensive rock in the southwest group is the granodiorite of Dinkey Creek, which forms the shores of Huntington Lake. This rock is medium gray, equigranular in some places but porphyritic in others, and generally contains discoidal inclusions of dark fine-grained material. The origin of these dark-colored inclusions is not known, but they may represent refractory material that was softened but not completely melted when the granitic magmas were formed at depth. The other members of the southwest group are lighter colored rocks that lack dark inclusions.

The northeastern group includes two principal granitic rocks, a very light-colored equigranular one called the alaskite of Graveyard Peak, and a somewhat older, darker, strongly sheared rock called the granodiorite of Margaret Lakes. The alaskite encloses large irregular masses of dark rock that are labelled on the map "quartz diorite and related mafic plutonic rocks"; very likely these masses represent strongly recrystallized remnants of the old volcanic rocks.

The principal members of the youngest group of intrusive rocks (those that underlie the central part of the quadrangle) are the Mount Givens Granodiorite and the granodiorite of Lake Edison. Representative samples of the Mount Givens Granodiorite, the oldest member of this young group, have been dated by radiometric methods at 82 to 87 million years. The Mount Givens Granodiorite is equigranular and contains abundant dark, preferentially oriented discoidal inclusions in the east and many large crystals of potassium feldspar but few dark inclusions in the west. In comparison with the Mount Givens Granodiorite, the granodiorite of Lake Edison is of about the same composition but is finer grained and less variable in appearance. The granodiorite of Lake Edison is intruded by a rather coarse-grained light-colored rock, the quartz monzonite of Rock Creek Lake, and the Mount Givens Granodiorite is intruded by a group of generally fine-grained, light-colored rocks called "fine- to medium-grained quartz monzonite and granodiorite."

Erosion, volcanic eruptions, and glaciation.--Following the emplacement and solidification of the granitic rocks, the area was deeply eroded, doubtless to a depth of thousands of feet. The old sedimentary and volcanic rocks and the alaskite of Graveyard Peak are especially resistant to weathering and erosion, so that Kaiser Ridge and Silver Divide now stand high. During the late Miocene or early Pliocene Epochs, perhaps 10 to 15 million years ago, the Sierra Nevada was tilted westward, causing west-flowing streams first to entrench themselves in canyons, and then to widen the canyons to broad valleys, one of which is the dissected upland valley that occupies the region between Silver Divide and Kaiser Ridge. About 3.5 million years ago, according to radiometric age determinations, volcanoes near Pincushion Peak, Saddle Mountain, and other scattered localities spewed out lava which flowed into and along this valley. At about the same time or shortly thereafter, the range was again tilted westward, causing the trunk streams to cut the deep inner canyons in which they now flow and the tributaries to intricately dissect the old landscape. Too little time has elapsed for the old valleys to be regraded to the trunk streams.

During the Pleistocene Epoch, which began 2 to 3 million years ago, the higher parts of the Sierra Nevada were repeatedly mantled with glaciers. The earliest known glaciation consisted of a system of confluent glaciers that buried all but the highest peaks in the quadrangle. A long period of erosion followed this glaciation, and all that is left are remnants of moraines and scattered boulders that were left behind by the ice sheets, and weathered and eroded glacially carved landforms in the bedrock of high areas. Later glaciations were less extensive; nevertheless huge valley glaciers flowed down both the San Joaquin River and its South Fork, and hanging (alpine) glaciers carved cirque basins, now the sites of lakes and tarns, in the flanks of Kaiser Ridge and Silver Divide. Vast quantities of debris were moved downstream by the glaciers and deposited along their sides and at their ends to form the morainal ridges we now see. Rocks carried by glaciers scraped across bedrock, polishing the rock and leaving striae and chatter marks that are still visible in many places. The ice ages ended only about 10,000 years ago, so that there has been little time for subsequent modification of the glacially carved landscape.

Since the ice ages vast quantities of rhyolite pumice erupted in the Mammoth Lakes region to the north. A great pumice plume must have been blown southward by the wind, for pumice fragments have been found across the entire Kaiser Peak quadrangle in decreasing abundance southward. Scattered pumice fragments can be easily collected along Kaiser Ridge between Kaiser Pass and Mount Givens; north of the Margaret Lakes accumulations of pumice a foot or more thick are common in small pockets in bedrock and in alluvial basins.

SELECTED BIBLIOGRAPHY

Bateman, P.C., 1965, Geologic map of the Blackcap Mountain quadrangle, Fresno County, California: U.S. Geol. Survey Geol. Quad. Map GQ-428, scale 1:62,500. Geologic map of the quadrangle to the southeast.

Bateman, P.C., 1968, Geologic structure and history of the Sierra Nevada: Missouri Univ., Rolla, Jour., no. 1, p. 121-131. A brief summary of the geologic structure and geologic history of the Sierra Nevada.

Bateman, P.C., Clark, L.D., Huber, N.K., Moore, J.G., and Rinehart, C.D., 1963, The Sierra Nevada batholith--a synthesis of recent work across the central part: U.S. Geol. Survey Prof. Paper 414-D, p. D1-D46. A technical description of the geology of the pre-granitic and granitic rocks of the central Sierra Nevada based on studies made prior to 1962.

Bateman, P.C., and Eaton, J.P., 1967, Sierra Nevada Batholith: Science, v. 158, no. 3807, p. 1407-1417. A technical article in which a hypothesis for the origin of the granitic rocks of the Sierra Nevada is developed; the seismic properties of the Sierra is discussed.

Bateman, P.C., and Wahrhaftig, Clyde, 1966, Geology of the Sierra Nevada, in Bailey, E.H., ed., Geology of northern California: California Div. Mines and Geology Bull. 190, p. 107-172. A comprehensive summary of Sierran geologic history; emphasizes erosional history and the development of landforms.

Birman, J.H., 1964, Glacial geology across the crest of the Sierra Nevada, California: Geol. Soc. America Spec. Paper 75, 80 p. Describes the glacial deposits of an area centered on the Kaiser Peak quadrangle.

Dalrymple, G.B., 1963, Potassium-argon dates of some Cenozoic volcanic rocks of the Sierra Nevada, California: Geol Soc. America Bull., v. 74, no. 4, p. 379-390. Radiometric ages of some volcanic rocks of the Sierra Nevada, including lava flows in the Kaiser Peak quadrangle.

Dalrymple, G.B., 1964, Cenozoic chronology of the Sierra Nevada, California: California Univ. Pubs. Geol. Sci., v. 47, 41 p. A later report on the radiometric ages of Sierran volcanic rocks giving additional data.

Hamilton, W.B., 1956, Variations in plutons of granitic rocks of the Huntington Lake area of the Sierra Nevada, California: Geol. Soc. America Bull., v. 67, no. 12, pt. 1, p. 1585-1598. A study of compositional variations in granitic rocks of the south part of the Kaiser Peak quadrangle and adjoining areas.

Hamilton, W.B., 1956, Geology of the Huntington Lake area, Fresno County, California: California Div. Mines Spec. Rept. 46, 25 p. Descriptive geology of an area centered on Huntington Lake and including the south part of the Kaiser Peak quadrangle.

Huber, N.K. 1968, Geologic map of the Shuteye Peak quadrangle, Sierra Nevada, California: U.S. Geol. Survey Geol. Quad. Map GQ-728, scale 1:62,500. Geologic map of the quadrangle to the west.

Huber, N.K. and Rinehart, C.D., 1965, Geologic map of the Devils Postpile quadrangle, Sierra Nevada, California: U.S. Geol. Survey Geol. Quad. Map GQ-437, scale 1:62,500. Geologic map of the quadrangle to the north.

Hurley, P.M., Bateman, P.C., Fairbairn, H.W., and Pinson, W.H., 1964, Preliminary investigation of Sr^{87}-Rb^{87} relationships in the Sierra Nevada plutonic rocks [abs.]: Geol. Soc. America Spec. Paper 76, p. 85. Strontium-rubidium age determinations and other isotopic studies of some of the granitic rocks of the central Sierra Nevada.

Kistler, R.W., Bateman, P.C., and Brannock, W.W., 1965, Isotopic ages of minerals from granitic rocks of the central Sierra Nevada and Inyo Mountains, California: Geol. Soc. America Bull., v. 76, no. 2, p. 155-164. Potassium-argon age determinations of some granitic rocks of the central Sierra Nevada.

Matthes, F.E., 1960, Reconnaissance of the geomorphology and glacial geology of the San Joaquin Basin, Sierra Nevada, Calif.: Geol. Survey Prof. Paper 329, p. 1-60. A posthumous report by a renowned student of Sierra Nevada physiography of the development of the landforms in the San Joaquin River drainage.

Peck, D.L., 1964, Preliminary geologic map of the Merced Peak quadrangle, California: U.S. Geol. Survey Mineral Inv. Field Studies Map MF-281, scale 1:48,000. Uncolored preliminary geologic map of the quadrangle to the northwest.

Rinehart, C.D., and Ross, D.C., 1964, Geology and mineral deposits of the Mount Morrison quadrangle, Sierra Nevada, California, with a section on A gravity study of Long Valley, by L.C. Pakiser: U.S. Geol. Survey Prof. Paper 385, 106 p. A comprehensive report on the geology of the quadrangle to the northeast; includes a geologic map.

Sherlock, D.G., and Hamilton, Warren, 1958, Geology of the north half of the Mount Abbot quadrangle, Sierra Nevada, California: Geol. Soc. America Bull., v. 69, no. 10, p. 1245-1267.