MAP GQ-548

DEPARTMENT OF THE INTERIOR
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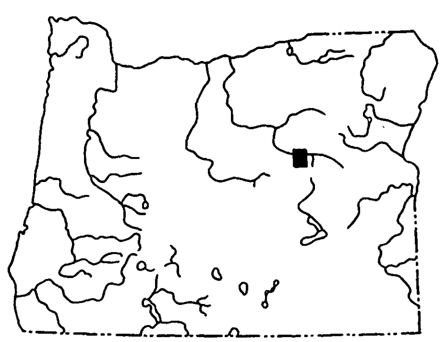
GEOLOGIC QUADRANGLE MAPS OF THE UNITED STATES

GEOLOGIC MAP OF THE MOUNT VERNON QUADRANGLE GRANT COUNTY, OREGON

By
C. Ervin Brown and T. P. Thayer



QUADRANGLE LOCATION

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GEOLOGIC HISTORY OF THE MOUNT VERNON QUADRANGLE GRANTY COUNTY, OREGON

By

C. Ervin Brown and T. P. Thayer

The geologic history of the Mount Vernon quadrangle can be divided into four main episodes: pre-Late Triassic; Late Triassic(?) and Early Jurassic; Late Jurassic(?) and Early Cretaceous; and Tertiary and Quaternary.

Pre-Late Triassic sedimentation, volcanism, and orogeny

The Paleozoic rocks indicate major volcanism and rapid deposition of materials under marine conditions; complete gradations from massive pillow lava to hornblende schist, and comparable variations in sedimentary rocks document an episode of strong local dynamic metamorphism. The Paleozoic rocks have been intruded, and in places completely disrupted, by serpentinite of the Canyon Mountain Complex and by associated gabbro and quartz diorite. Most of the serpentinite is highly sheared and was moved plastically, mainly before deposition of Upper Triassic(?) rocks, but also as later diapiric intrusions into Upper Triassic(?) rocks. By Late Triassic time the Canyon Mountain Complex had been exposed to erosion, for its debris is found in sedimentary rocks of that age.

Late Triassic(?) and Early Jurassic volcanism, sedimentation, and tectonism

The rocks of the Aldrich Mountains Group (Brown and Thayer, 1966) attain a maximum composite thickness of at least 27,500 feet within the Mount Vernon quadrangle. Pillow lavas in the area northeast of the Aldrich Mountains fault, interlayered lava in the Fields Creek Formation in the Aldrich Mountain quadrangle (Thayer and Brown, 1966a) to the west, and great thicknesses of tuff and tuffaceous graywacke testify to major volcanic activity. The distribution of tuffs and lava flows suggests that the major volcanic centers were to the north.

Intermittent volcanism and tectonism accompanied by rapid and nearly continuous sedimentation produced complex stratigraphic and structural relations in the Aldrich Mountains. The series of related geologic events that occurred in Late Triassic(?) and Early Jurassic time can be divided into 4 major phases.

Phase 1 was dominated by deposition of the Fields Creek Formation which unconformably overlies rocks of pre-Late Triassic age 3 to 5 miles southeast of Mount Vernon and in the Aldrich Mountain quadrangle to the west. Volcanic eruptions during Phase 1 contributed much material to the sedimentary basin. In the Aldrich Mountain quadrangle the basal part of the Fields Creek includes interlayered basaltic pillow lavas and in the Mount Vernon quadrangle approximately the upper half of the formation is the andesitic Cinnabar Tuff Tongue.

Phase 2 was mainly a period of very rapid deposition of the Laycock Graywacke in a basin that was being folded and faulted. The events of Phase 2 were initiated by upward flexing of Fields Creek beds along the eastern margin of an uplifed landmass. The upturning of these beds, which are now in the west limb of the Packsaddle syncline, preceded development of the fold as a whole.

This initial uplift caused a major change in sedimentary environments evidenced in the transition from andesitic tuff of the Fields Creek to shale and graywacke of the Laycock. Minor erosion of the upturned slope and a westward feathering out of beds produced the abrupt pinchout of the Laycock Graywacke and the divergence of dips at the contact between these formations in the west limb of the Packsaddle syncline.

As deposition of the Laycock continued, the McClellan anticline rose and reverse movement on the Moon Creek fault occurred along the axis of the newly formed Packsaddle syncline. This fault cuts basal Laycock Graywacke, but appears to have been buried by slightly younger beds. The first major movement of the Aldrich Mountains fault also occurred at about this time. The mixed lithology of the conglomerates in the Laycock Graywacke in the northeast limb of the McClellan anticline was derived from two different sources: (1) very coarse bouldery debris of gabbroic and Paleozoic sedimentary, volcanic, and metamorphic rocks must have come from the hanging-wall block of the Aldrich Mountains fault to the north, but (2) well-rounded cobbly to pebbly mudstone conglomerates clearly were eroded from upturned parts of the Fields Creek Formation or similar Triassic(?) rocks to the west. On the northeast slopes of First and Second Peaks, the conglomerate seems to interfinger with the uppermost beds of the Cinnabar Tuff Tongue in the Fields Creek Formation. Thus "cannibalization" of the upturned beds of the Fields Creek was producing mudstone conglomerates in the basal Laycock Graywacke during the waning stages of volcanism that produced the Cinnabar Tuff Tongue of the Fields Creek Formation.

Deformation of the basin reached a peak of intensity when reverse faults were formed parallel to the axis of the northwest-trending folds. The McClellan Creek fault developed along the axial zone of the syncline paralleling the McClellan anticline on the northeast, and the Riley Creek horst is essentially the overturned limb of that syncline. The dropping of the wedgeshaped block between the Cinnabar Mountain and Aldrich Mountains faults occurred in the late stages of this deformation. Filling this down-dropped part of the basin resulted in the very thick section of Laycock Graywacke in the southeastern part of the mapped area.

Volcanic eruptions contributed much debris to the Laycock Graywacke and were particularly important in the later stage of Phase 2 when the Ingle Tuff Tongue was laid down. Phase 2 closed with the dying out of volcanism, and the low areas caused by deformation were finally filled by the Laycock.

Phase 3 was a period of uniform deposition in a well-graded basin. The calcareous detrital rocks of the Murderers Creek Graywacke reflect an abrupt change in source material. The nearest present-day source of limestone is 35 miles or more to the southwest. Although the change to limestone debris was abrupt, a lens, a precursor of Murderers Creek lithology, is interfingered with upper Laycock Graywacke at Riley Creek Butte. Locally the change to Murderers Creek deposition was initiated by submarine slides that formed thick lenses containing limestone blocks in the basal beds, as at Ingle Rock.

After the uniform 2000-foot thick sheet of Murderers Creek was deposited, sedimentation continued with the laying down of tuffaceous noncalcareous beds of the Keller Creek Shale. The change of lithology indicates a different source of debris and reflects a resurgence of volcanism which continued intermittently into Middle Jurassic time (Dickinson and Vigrass, 1965).

Phase 4 was characterized by the development of the system of folds from the northeast-trending Keller Creek syncline east to the northwest-trending Fall Mountain syncline. Recurrent movement along the reverse Aldrich Mountains fault, totalling 12,000-15,000 feet, probably caused overturning of adjacent strata along its entire length. Movement along the fault ended to the west against the Cinnabar Mountain fault, which probably acted as a transverse sliding surface for the hanging-wall block.

Late Jurassic(?) and Early Cretaceous dioritic intrusions

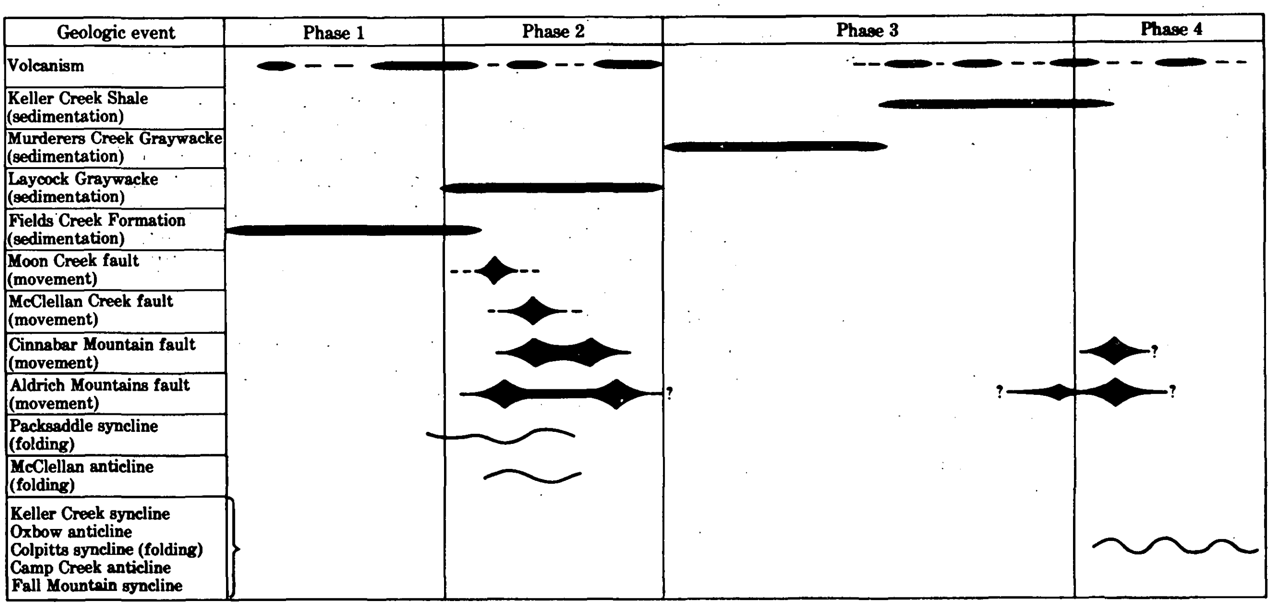
The sills, dikes, and stocks of dioritic rocks in the western part of the quadrangle were intruded in Late Jurassic(?) to Early Cretaceous time and are related to the Idaho batholith (Thayer and Brown, 1965).

The sharp unsheared contacts and well-defined textures of these rocks indicate intrusion of highly fluid magma into a stable environment. This contrasts markedly with the strong deformation that characterized the emplacement of the Canyon Mountain Complex (Thayer, 1963).

Tertiary and Quaternary volcanism, sedimentation, and tectonism

Eocene to early Miocene: During Eocene time basaltic to andesitic flows, volcanic ash, breccia, and conglomeratic mud flows of the Clarno Formation were piled up to thicknesses ranging from several hundred to a few thousand feet. An abundance of lava flows in the area east of Mount Vernon and their absence in the Aldrich Mountain quadrangle to the west (Thayer and Brown, 1966a) imply that the volcanic vents were a short distance to the northeast and east. The Clarno Formation was deposited on a rolling pre-Tertiary erosion surface that probably had at most a few hundred feet of local relief.

Between the end of Clarno volcanism and the first outpouring of Picture Gorge Basalt, the mapped area appears to have stood high. Deep lateritic soils like those on the Clarno Formation farther west (Waters and others, 1951; Hay, 1963) have not been found, nor is there evidence that the John Day Formation of Oligocene and Miocene age ever covered this area. The quadrangle is, therefore, just southeast of an ancient broad structural and topographic basin, the John Day Basin, which lasted from early Oligocene through early Pliocene time.



SEQUENCE OF VOLCANISM, SEDIMENTATION, AND TECTONISM IN THE MOUNT VERNON QUADRANGLE DURING LATE TRIASSIC AND EARLY JURASSIC TIME

Middle Miocene to middle Pliocene: The Picture Gorge Basalt piled up as a lava flood in the John Day Basin and lapped up against the mountains that rimmed it on the south and east. The Mascall Formation and rhyolitic facies of the Columbia River Group (Tcr) are believed to be stratigraphically equivalent products of late Miocene and early Pliocene rhyolitic and basaltic eruptions (Thayer and Brown, 1966b). The Mascall Formation consists mostly of ashy material and some gravel deposited on a broad, marshy flood plain that extended out into the John Day Basin, over the Picture Gorge Basalt. The interbedded rhyolitic units and basalt flows (Tcr) were probably near the edge of an active volcanic area from which debris-laden streams flowed.

The modern configuration of the area began to evolve during major folding and faulting in early Pliocene time. The Columbia River Group and older rocks were folded steeply under north-south compression to form the Aldrich Mountain anticline and a companion syncline on the north.

The John Day fault formed essentially as a steep reverse fault along the axis of the syncline during later stages of the folding. The complex system of faults north of the John Day River probably developed during the folding. The soft Mascall Formation was stripped off as folding progressed, and by the beginning of middle Pliocene time, only remnants of it were preserved in the bottom of the faulted syncline.

Middle Pliocene to Recent: The fanglomerates and gravels of the Rattlesnake Formation were deposited, under climatic conditions very similar to the present, along the sides of a broad valley which the ancestral John Day River followed westward to the present site of Picture Gorge, 27 miles west of Mount Vernon. The tuff member was presumably formed by a single eruption or closely related eruptions of rhyolite that flowed as hot ash up the John Day River valley. Exposures southeast of Dayville in the Aldrich Mountain quadrangle show that the tuff lies on at least 350 feet of gravel in places, and northwest of Mount Vernon where the tuff is below the valley floor, more than 500 feet of gravel lies on it. In the vicinity of Mount Vernon the tuff member has been tilted southwest about 5°, and differences in positions of outcrops north and south of the John Day River show that the tuff has been displaced vertically about 400 feet along the John Day fault. The total amount of dislocation of the base of the Rattlesnake Formation by folding and faulting, however, probably is at least 1,000 feet in places between Mount Vernon and Picture Gorge. Comparisons of the thicknesses of gravel above and below the tuff, and estimates of displacement along the John Day fault suggest that in the vicinity of Damon and Clark Creeks at the bottom of the downwarp, the base of the Rattlesnake Formation may be 600-800 feet below the present valley floor.

The last movement on the John Day fault and incision of the John Day River into its present narrow valley followed a considerable period of erosion, and probably occurred in middle Pleistocene time. North of the river the broad pediment surface cut on the Rattlesnake Formation extends northward a mile or more across bevelled basalt flows. Comparable physiographic relations are found between the Rattlesnake and pre-Upper Triassic rocks south of the river, but the pediment remnants are higher and have been reduced to narrow ridges. In short, the pediment surfaces on the two sides of the valley differ in altitude by 250 to 300 feet. The greater dissection south of the river indicates erosion of the raised block while the northern block was still graded to the John Day River. The post-Rattlesnake movement on the fault died out about at the west edge of the quadrangle. Discovery of skeletons of Equus and Elephas primigenius (Mammoth) near Mount Vernon "...in an alluvial deposit not much above the level of the river" (Merriam, 1901, p. 313) dates the major trenching of the John Day River as pre-Wisconsin.

Ground Water Resources in the John Day Valley

Ground water in the John Day River valley is important as the main source of uncontaminated domestic water and a supplemental water supply for irrigation.

Wells drilled in serpentine in the vicinity of Canyon City, about 2 miles east of the mapped area, have been uniformly unproductive. Because of its highly sheared, "pasty" nature, serpentine probably is the least favorable local reservoir rock for ground water. Similarly the Paleozoic metavolcanic rocks and those of the Aldrich Mountains Group are, except where jointed, nearly as impermeable as serpentine. The favorable rocks, in addition to gravels on the valley floor, are the Rattlesnake Formation, the Picture Gorge Basalt and, possibly, the Clarno Formation.

The rubbly permeable zones at the tops of flows in the Picture Gorge Basalt are good aquifers and as a rule can be expected to yield about 1 gallon of water per minute (gpm) per foot of hole below the water table at a drawdown of 50-100 feet (Newcomb, 1961, p. A-2). For example, the 12-inch well at the John Day city hall (city well no. 1) 8 miles east of Mount Vernon, is 240 feet deep in basalt and yields 210 gpm with 185 feet of drawdown (John Day Water Department, oral communication, 1961).

The deformation of the basalt has produced important structural traps for ground water. The John Day fault and the southward-dipping rocks in the down-thrown block to the north together form a major structural reservoir (Newcomb, 1961, p. A6). John Day city well No. 2, drilled in basalt and rhyolite breccia of the Columbia River Group, is located approximately 1,500 feet north of the fault. The well was drilled to 310 feet and cased with 12-inch casing. During a test in 1953, it had an artesian flow of 100 gpm, and at a drawdown of 180 feet yielded 320 gpm (John Day Water Department, oral communication, 1961). Another well drilled east of No. 2 in 1963 in the same geologic situation also has strong artesian flow (Newcomb, written communication, 1965). In contrast, a 715-foot well located about 1,000 feet southeast of the center of Mount Vernon was nearly dry. The driller's report indicated "clay, hard nodules in soft clay, buttery clays..." (Newcomb, written communication, 1964). Cuttings from this well were examined by Thayer and interpreted as gouge and breccia in the John Day fault zone. This well and the John Day city well No. 2 show that artesian flow is possible from wells in basalt north of the John Day fault but not in it. West of Mount Vernon and north of the John Day fault the tuff member and gravelly beds in the Rattlesnake Formation also might yield artesian flows (see section A-A′).

Because of the importance of the John Day fault to the production of ground water, it should be emphasized that its trace is concealed by alluvium at most places. The mapped location of the fault is inferred from exposures less than a mile west of the Mount Vernon quadrangle, from the well southeast of Mount Vernon, and from exposures in the vicinity of John Day.

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