DESCRIPTION OF THE MARYSVILLE SHEET.

TOPOGRAPHY.

The Marysville atlas sheet includes the territory between the meridians 121° 30′ and 122°, and the parallels 39° and 39° 30′. The area is 34.5 miles long and 27 miles wide, and contains 925 square miles. It includes portions of Butte, Yuba, Sutter, and Colusa counties, California.

The broad alluvial plains of the Sacramento and Feather rivers occupy the larger part of the area. These rivers pursue a winding course on low ridges. This elevated channel is characteristic of streams which wander through flood-plains, the banks being built up by sediments deposited during high water. The tributaries, as a consequence, before reaching the main stream are usually turned aside and converted into stagnant sloughs, overflowing large areas during the wet season. Extensive tracts of land must, therefore, to be available for agriculture, be protected by levees. On both sides of the Sacramento River there are broad belts of swamp lands, which are annually overflowed, and are usually covered by a dense growth of tule (*Scirpus lacustris*). There are also in these areas several lake-like depressions in which the water remains the whole year. Minor sloughs and swamps occur on both sides of the Feather River. A considerable area north-northeast of Marysville is also of a marshy character, though usually dry during the summer. The elevation of Marysville is 66 feet above the sea. The channel of the Yuba River has, during the last decade, been choked by an excessive amount of fine débris brought down from the hydraulic gravel mines of the Sierra Nevada, and, as a consequence, the townsite of Marysville, formerly high and dry, is now considerably lower than the river at high-water mark. The sandy flood-plain of this river is now from 1½ to 3 miles wide, and the channel shifts every season.

In the northeastern corner of the area the outlying foothills of the Sierra Nevada reach an elevation of 500 feet. The first hills appear as broad, low, flat-topped elevations. The bed-rock series appears east of these as a low ridge with north-northwest direction.

In pronounced contrast to these monotonous plains and low rolling hills, there rise, in the center of the area, between the two principal rivers, the Marysville Buttes, the central peaks of which attain an elevation of about 2,000 feet. They form a nearly circular group of mountains, with a diameter of 10 miles. Their topography can better be described in connection with the geology.

The plains and the lowest, rolling foothills are, on the whole, destitute of arboreal vegetation, though in places scattered oak trees impart a park-like character to the landscape. The tule-covered areas on both sides of the Sacramento River have been mentioned above. The river banks usually support a dense vegetation of brush and willows, and in the dryest places, of oaks also. The higher foothills in the northeast corner, as well as the Marysville Buttes, are covered by white and black oak, live oak, digger pine, and underbrush—largely *Ceanothus*.

The Marysville Buttes and the higher foothills in the northeast corner are utilized as pastures, as are also to a certain extent the first low rolling foothills. When irrigated, however, the latter are in many places adapted to horticulture; oranges, lemons, olives, peaches, and other semi-tropical fruits growing well. Where the foothills gradually change to the level, richer bottom-lands, wheat fields replace the pasture lands, though fruit trees of all kinds also succeed wonderfully well, except where the hardpan is near the surface.

The climate is of a subtropical character, which prevails everywhere in the Great Valley of California. Snow hardly ever falls; the lowest temperature recorded is 18° F., the highest being about 115° F. The average rainfall, comprised in the winter months between October and May, is 18 inches at Marysville.

GEOLOGY.

The geologic formations of the Marysville sheet form two very distinct groups of rocks, which occur in areas that may be described separately, the first being the district of the alluvial plains and the foothills of the Sierra Nevada, the second consisting of the Marysville Buttes and representing an isolated, extinct volcano.

BED-ROCK SERIES.

This series consists of sedimentary rocks which were forced into a nearly vertical position at or before the post-Jurassic upheaval, together with the associated igneous rocks.

JURATRIAS AND OLDER.

Diabase and porphyrite.—The foothills of the Sierra extending into this area are formed of representatives of the bed-rock series or the compact pre-Cretaceous rocks of the mass of the Sierra Nevada. They are diabases and augite-porphyrites—green, massive, and hard rocks, composed principally of feldspar and augite. These rocks are of igneous origin, and were probably extruded during the Juratrias period.

SUPERJACENT SERIES.

This series consists of late Cretaceous, Eocene, Neocene, and Pleistocene sediments, lying unconformably upon the Bed-rock series, together with igneous rocks of the same periods.

NEOCENE AND PLEISTOCENE.

The level plains of the Sacramento Valley are composed of deposits of Neocene and Pleistocene age.

Auriferous gravels (fluviatile).—The Neocene area south and east of Lava Beds is composed of fine shale, with sandy layers, and fine gravel. These deposits are of the age of the fluviatile Auriferous gravels on the slope of the Sierra Nevada, and are therefore described as such, although the material does not contain gold enough to be worked profitably. Some of the tuff to the south of Lava Beds seems to contain andesitic detritus. These Neocene deposits evidently represent the flood-plain of an ancient stream of the Sierra Nevada near the point where it débouched into the gulf which then occupied the present Great Valley of California.

The Neocene area described probably extends much farther to the south than is indicated on the map, but is overlain by Pleistocene hardpan and gravel to a greater or less depth. The line separating the earlier Pleistocene from the Neocene area must be taken as an approximate one.

Earlier Pleistocene.—There are large tracts of deposits of earlier Pleistocene age along the eastern border of the area, evidently formed along the shore of the shallow gulf that occupied the Great Valley during that epoch. As a rule, they form tables gently rising eastward, and, beginning at an elevation of 70 or 80 feet, extend up to about 350 feet above the sea, where they meet the more abrupt rocky foothills of the Sierra Nevada. The strata consist of clays, hardpan, sands, and gravel which is chiefly siliceous and grows coarser near the old shore-line. This gravel is made up of pebbles probably largely derived from Neocene deposits which have been worked over by waves. By the sorting process the finer sediments have been removed and the pebbles of softer igneous rocks decomposed and washed away, leaving the pebbles of quartzite and other quartzose rocks, which better resist the action of water. In a general way, the earlier Pleistocene may be distinguished by the red soil from the later, dark alluvial areas. Scattered Pleistocene gravel occurs on the Neocene area to the south of Oroville and Lava Beds. The general character of the soil is that of a gravelly or sandy reddish loam.

Exposures made by Honcut Creek, about a mile east of Moore's Station, show 20 feet of gravel mixed with coarse sand, conformably underlain by 4 feet of white or yellowish hardpan, which in some places has a tuffaceous aspect. This rests directly on diabasic rocks, showing that at this place the Ione formation (Neocene), which was certainly deposited all along the border of the valley, had already been eroded when the earlier Pleistocene beds were deposited. The whole area between Moore's Station, Palermo, and a line drawn a mile or two east of Feather River, presents this same section, being covered by gravel and underlain by a stratum of more or less sandy hardpan.

Between the Honcut and the Yuba, the gently rolling, gravelly lands begin near the boundary line of the sheet, and one low isolated hill has been preserved near the Honcut on the west side of the railroad. These hills are made up of yellowish clays, hardpan, and sand, covered by a stratum of gravel of varying thickness.

South of the Yuba the alluvial sands are heavy near the rivers, while a couple of miles away from them the hardpan and gravel come closer to the surface. At Reed's Station the wells show a section of 1 to 6 feet of red soil, 1 foot of clay, 3 feet of hardpan, below which is a stratum of sandy gravel. Southwest and south of Reed's the hardpan is covered by only a shallow layer of adobe or red soil.

Alluvium.—Under alluvium are here classed the fluviatile deposits of clays, sands, and gravels, formed by the steady erosion of the older formations by the shifting streams since the Great Valley became dry land. The alluvium has been formed very largely by the working over and the redeposition of the earlier Pleistocene and Neocene strata covering the valley. There is excellent reason to believe that these alluvial beds are relatively shallow, probably in few places deeper than 100 feet, and that they rest on a very deep series of estuarine and marine strata of early Pleistocene, Neocene, Eocene, and Cretaceous age.

The soil of the alluvial plains is usually of dark color, owing to abundant humus, and is, as a rule, of great fertility. On the eastern side of the Feather River a reddish color frequently shows the influence of the adjoining areas of earlier Pleistocene beds derived from the ferruginous rocks of the Sierra Nevada.

On this side the alluvium is much thinner than over the rest of the plains; it rests as a shallow mantle on the earlier Pleistocene, which is sometimes exposed in the creek beds, and the boundary between the two formations is usually very indistinct. Some of the thin alluvial areas overlying the earlier Pleistocene north of Moore's Station are not noted on the map.

Near Yuba and Feather rivers this thin mantle becomes heavier and consists largely of sand, which, at a depth of 50 feet or less, is underlain by hardpan and gravel. At Marysville the Buckeye Mill well has been bored to a depth of 218 feet in clay, sand, and gravels; between the depth of 80 and 140 feet, clay containing impressions of shells was penetrated. These strata may without doubt be regarded as older than the alluvium. In Yuba City wells were bored through sandy soil 20 feet; quicksand, 6 to 20 feet; and blue clay, 40 feet; but in other places south of the town the sand is much deeper. Five miles southeast of Marysville about 30 feet of sand generally overlies well-washed gravel. The former is regarded as alluvial. A little farther southeast, near Reed's Station, the early Pleistocene comes much closer to the surface.

A well bored in the tule lands south of the Marysville Buttes to a depth of nearly 400 feet showed the following section:

	Feet.
Surface soil (rotten tule and loam) . .	12
Hardpan	1
Alternate strata of blue clay and white sand	195
Blue and white quartz gravel	a few
Sand and blue clay alternating . . .	183

In this section it is of course impossible to indicate the lower limit of the alluvium.

In the northern part of Sutter County, near the Feather River, the surface section is about as follows:

	Feet.
Sandy clay	3
Hardpan	3
Yellow clay . . . . . at least	25
Gravel	

Near Colusa, on the banks of the Sacramento River, there are, as a rule: sandy loam, 18 feet; then clay and sand, 27 feet, underlain by gravel. North of Marysville, up to the Honcut, about 30 feet of sand and clay, sometimes with hardpan, overlies gravel. It is probable that only 10 or 15 feet of this belongs to the alluvial series.

The recent river gravels of the Feather River below Oroville cover an area of several square miles. As may be seen at the numerous shafts sunk in them for gold, they are 20 feet or more in depth. About two miles to the west of Lava Beds these river gravels give place to more-sandy deposits, and gradually merge into the finer alluvium of the valley.

The high isolated mountain group of the Marysville Buttes, rising with serrate and fantastic outlines from the monotonous plains of the Sacramento Valley, is in more than one respect an object of interest. On the western side the overflowed lands of the Sacramento River encircle it, while toward the east and north a gentle slope leads up from the Feather River to the base of the buttes, which may be assumed to coincide with the 100-foot contour line.

The detailed topography and the geology of this mountain group are so intimately connected that they may best be described together.

In general, it may be said that the Marysville Buttes are an extinct volcano of probably late Neocene age, the internal structure of which is to a certain extent laid bare by erosion.

In any view from a distance two distinct features of the mountain group are always noted; first, the peripheral slopes, reaching up to 600 or 700 feet in a long, gentle curve; second, the abrupt and jagged interior peaks and domes, of which the South Butte and the North Butte are the most prominent. It is probable that when the volcano was in active eruption it formed one great cone, such as that of Vesuvius, Etna, or Fuji-yama, and that its original form can be reconstructed with considerable accuracy by carrying up the curves of the lower slopes, with gradually increased declivity, until they culminate in a summit, high above the present peaks. The drainage is radial, the creeks and ravines originating in the central mass and flowing thence north, east, south, and west.

There are three divisions of the buttes, which are topographically and geologically distinct. They are: 1. The peripheral tuff ring. 2. The interior ring of upturned sedimentary rocks. 3. The central core of igneous rocks.

1. *The tuff ring.*—The first subdivision corresponds to the gentle slopes mentioned above, and is made up of a successive series of beds of mud lava poured out from the vents of the volcano. These flows form grassy slopes covered with rough bowlders of eruptive rocks, and sustain a scant, brushy vegetation. In its typical development this mud lava consists of finely ground up detritus in which lie imbedded angular fragments of andesite, or more rarely rhyolite, of all sizes. The color of this tuff is gray or brownish-gray. Very frequently, however, there is more or less sedimentary material—clay, sand, or gravel—mixed with these mud lavas, or tuffaceous breccias, as they might be called. The abundance of this sedimentary material is explained by the loose character of the beds through which the eruptive masses must have forced their way. These mud lavas show a close analogy with similar enormous masses largely covering the flank of the Sierra Nevada. They probably poured out as a semi-fluid, hot mud, and were only to a less extent the result of ash showers. Narrow gulches or defiles have been cut through this ring of mud-flows, leading from crater-like valleys with level bottoms, which are often of roughly circular shape and surrounded by steep walls of tuff or massive andesite. Such craters are the two valleys 3 miles south of Pennington, that south of the North Butte, and the South Butte Valley. There can hardly be any doubt that from these lateral craters a great deal, if not all, of the tuffs and breccias were ejected.

The tuff slopes emerge from the Pleistocene of the Great Valley at an elevation of about 150 feet, but scattered well-washed pebbles of quartzose, metamorphic, volcanic, and Neocene rocks occur up to an elevation of 300 or 400 feet, or to about the height reached by the Pleistocene sediments on the flank of the Sierra. No indications of terraces or shore-lines are, however, visible; they are also absent on the Sierra Nevada side.

At the base of the buttes the Pleistocene formations covering the tuffs consist of clayey and sandy beds, which at Sutter City are 55 feet deep and overlie a bed of gravel with volcanic pebbles.

2. *The upturned sediments.*—Between the exterior mud-flows and the massive core, and strongly contrasting with them, there often occur a series of smooth, rounded hills forming a frequently interrupted ring a mile or less in width. These hills are not volcanic, but consist of a series of sandstones (usually soft), white or dark clays, and gravelly beds. The beds are very much disturbed and dip at all angles and in all directions. As a rule, however, they dip away from the central core, and when near it stand at high angles, sometimes vertical. At the immediate contact with the massive volcanic rocks these sediments are usually hardened. No volcanic detritus of the same rocks of which the buttes are made up is found in them, and it may be regarded as certain that they were laid down before the period of volcanic activity.

The oldest of these formations belongs to the Tejon formation (Eocene); it has thus far been identified only in the sedimentary area northeast of the village of West Butte. It is here composed of greenish sandstones and shales, adjoining the volcanic masses and dipping at high angles east or west. A thickness of several hundred feet of sediments is exposed. Some of the beds contain abundant marine fossils, characteristic of the Tejon, among which a small coral (*Trochosmilia striata* Gabb) is most abundant. *Cardita planicosta*, a form eminently characteristic of the Tejon, is also found.

Overlying these beds are light-colored, soft sandstones and clays, dipping west at an angle of about 20°, which have been referred to the Ione formation. The other sedimentary areas consist largely, if not entirely, of these soft, light-colored beds. Near the tuffs they dip southward at 15° to 20°; approaching the central volcanic mass they usually stand almost vertical. In many places the beds are greatly disturbed and dip in various directions within short distances. The character of the beds makes it often difficult to ascertain strike and dip accurately. In the clays of these areas, in carbonaceous strata, impressions of leaves were collected. At two places marine fossils were found. The first is about 2 miles east of the South Butte; the second, 2½ miles north-northwest of the South Butte. The fossils, while not abundant, point to an early Neocene (Miocene) age; though it is not impossible that they are later Neocene (Pliocene). There is every probability that these beds are the exact equivalent of the Ione formation exposed along the foothills of the Sierra Nevada. Their aggregate thickness is very considerable, 1,000 feet being a fair minimum estimate. There are no dikes of massive volcanic rocks in the tuff mantle or in the upturned sediments; in fact, they appear to be entirely absent from the whole group. Instead, there are, both in the tuffs and in the sediments, a few eruptive masses having the form of chimneys or necks, appearing in horizontal sections with rounded or oblong outline. These necks, as a rule, protrude above the more easily eroded tuffs and sediments as dome-shaped hills. They consist of a porphyritic rock, intermediate between a rhyolite and a dacite.

3. *The central core.*—The central mass of the buttes consists principally of massive volcanic rocks, mixed with some breccias of the same materials. Most prominent, and occupying the largest area, are rough and jagged peaks and ridges of dark color, often showing beautiful columnar and laminated structures. They are made up of a normal hornblende-mica-andesite of very rough, trachytic appearance. Both the North Butte and the South Butte are formed of this material. The rock type does not correspond to any found on the western flank of the Sierra Nevada, but shows the closest analogy with the latest effusive masses from the Comstock and Bodie. Between these rough ridges are some smoother hills, consisting of mixed andesite and andesite-breccia. Besides these there are a few areas—west of the North Butte and on the south slope of the South Butte—of a white, fine-grained, normal rhyolite. Along the periphery of the central mass there are several rounded necks of a rhyolite approaching a dacite in composition. It is a light-colored—brown, gray, or purplish—compact rock with small white feldspars and abundant mica foils. The succession of these rocks is not established beyond doubt, but the acid, dacitic rhyolites appear to be later than the andesite. Small masses of enclosed sediments occur in a few places in the massive volcanic rocks; the clays are altered to a hard, dark, and brittle metamorphic rock. The absence of dikes and flows of molten material in this volcano is very remarkable. The eruptions took the form of large masses or necks, forced upwards through the loose sediments. The mass and the energy of the ascending lavas were so great that the surrounding sediments were uplifted more than 1,000 feet and bent upwards on all sides of the necks. It is probable that the ascending lavas were very viscid and comparatively cool, so that they, in some measure, acted as a plastic solid mass. The surrounding sediments, of which now a large part is probably eroded, prevented them from breaking out and forming lava-flows. It is also probable that the peripheral craters were formed during the later eruptions, and that the breaking out of the tuff-flows closed the period of volcanic activity. The Marysville Buttes represent a very unusual type of volcano, and many of their phenomena are difficult of explanation.

The time at which the volcano was active can, without much doubt, be fixed at the close of the Neocene or the beginning of the Pleistocene. It was probably a little later than the volcanoes which began their eruptions in the Sierra Nevada at the close of the Neocene. Since the time when the eruptions ceased, erosion has been actively engaged in destroying what the volcanic agencies builded, and the rate of the degradation can almost be measured as rock after rock falls from the lofty pinnacles and as the winter floods break down and sweep away the soft tuffs and sediments.

ECONOMIC GEOLOGY.

Gold-bearing gravels.—The gravelly bottom-lands of the Feather River below Oroville have been extensively mined for gold by means of shafts. The gold seems to have been found in the bottom layers of the recent river gravel. Numerous old shafts may still be seen near Lava Beds.

The shore gravels of early Pleistocene age that cover so much of the country between the Feather River at Oroville and Honcut Creek are frequently auriferous, and have been washed for gold over considerable areas. The little heaps of washed-over gravel may still be seen in some of the fields that have not yet been brought under cultivation.

Among the Neocene beds of the Marysville Buttes there are gravels of varying degrees of coarseness, some of the pebbles being 5 inches or more in diameter. All of the pebbles are well washed, and consist of quartz, siliceous sedimentary rock, diabase, granite, and serpentine. All of this gravel, as well as the volcanic mud-flows whenever containing a considerable mixture of gravel, are slightly auriferous, and the gulches and ravines in such areas have often been washed during the wet season with some profit. The gold is well rounded and, as a rule, is moderately fine. A few exceptionally large pieces, up to a value of five dollars, are reported to have been found. In some places these deposits might be profitably washed by the hydraulic process if it were possible to obtain sufficient water.

These coarse auriferous gravels are certainly a most interesting feature, occurring as they do so far removed from their source in the Sierra Nevada. There are no indications of quartz veins in the buttes.

Coal.—The Ione formation contains in places thin seams of an inferior lignite and carbonaceous clay. Prospecting has been carried on at various places in the South Butte Valley, and also 3 miles south of Pennington. Nothing of value has been found, nor is it very likely that any important deposit will be. Coal is also said to have been struck in a well 35 feet deep, 1 mile south of Sutter City; below the gravelly soil clayey strata were found overlain by coal.

Natural gas.—Gas in small quantities has been struck at Marysville at a depth of 200 feet, and at a less depth at Yuba City. It occurs also in the Marysville Buttes. It is not unlikely that deep wells would disclose enough gas to be of some economic importance.

About 1 mile southwest of the South Butte, in Neocene clay and sandstone, a well was sunk about 1864 to a depth of 20 feet, from which a small flow of natural gas issued. This well is still flowing. A well put down in 1892 close to the first one struck no gas, but ran into massive eruptive rock. On account of the very disturbed condition of the strata it seems extremely doubtful whether a large supply may ever be obtained.

Clay.—As usual, a large amount of clays is found in the Ione formation, some of which may be available for the manufacture of pottery.

Limestone.—An impure gray limestone occurs in the nearly vertical Neocene beds directly south of the South Butte. In the area of the volcanic tuffs, about 1,000 feet south of the South Pass road, 1½ miles south-southeast of the South Butte, is a spring deposit consisting mainly of calcite.

Building stones.—The rhyolite, being easily dressed, is locally used as a building stone. There is a quarry in the rhyolite area 3 miles northwest of Sutter City.

Soils.—The soils of the volcanic area are very shallow and, as a rule, not available for anything but pasture. The Neocene areas produce an extremely clayey soil of little strength. On the other hand, several of the crater valleys, as well as all of the level land surrounding the buttes, are covered with a deep and fertile soil, composed principally of wash from the volcanic areas.

Water supply.—On the banks of the Sacramento River good water is obtained at about 50 feet. Marysville and Colusa pump water from deep wells. The stratum carrying most water is at Marysville, 153 feet below the surface, and the water rises to within a few feet of the surface.

In the tule lands the water in the wells is apt to be brackish. Near Sutter City, south of the Marysville Buttes, the water plane is found 60 feet below the surface, in a gravel bed underlying clayey strata. South and east of Sutter City the water plane is higher. Near Pennington, water is found from 6 to 20 feet below the surface, clayey and sandy beds alternating. The water obtained in the wells is generally good, though somewhat hard. The deeper wells bored in the Sacramento Valley have, with few exceptions, failed to yield potable water, the water containing, as a rule, much carbonates and sulphates. The deepest well bored within the area of the sheet appears to be the one, mentioned above, in the tule lands south of Marysville Buttes. Deeper wells, if bored, are likely to strike artesian water, but whether it would be potable or not is doubtful.

Between the Yuba and the Honcut rivers the stratum of gravel underlying the hardpan carries potable water 10 or 12 feet below the surface. On the gravel hills along the eastern boundary the water plane is considerably deeper, the depth near Seven Mile House being 28 feet. South of Marysville the wells are generally about 30 feet deep. Near Reed's Station abundant water for irrigation is obtained at 50 feet, the water rising to within 12 feet of the surface.

All of the creeks issuing from the Marysville Buttes are dry during the summer, so that there is practically no water available for irrigation from this source. In the sedimentary areas there are, however, many strong springs flowing during the dryest seasons, and these are in some places utilized. The water is slightly alkaline.

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