## GEOLOGY

## GOLCONDA QUADRANGLE, NEVADA

By H. G. Ferguson, Ralph J. Roberts, and S. W. Muller

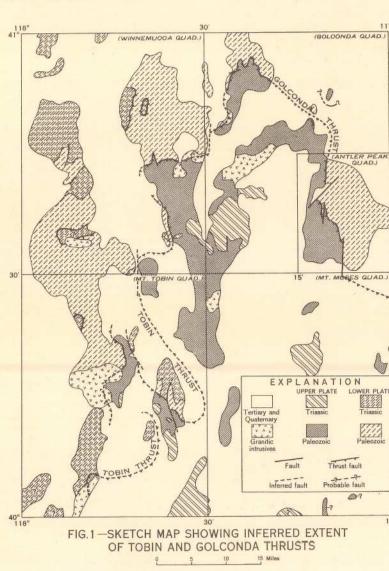
fined to the upper plate. The results of geologic mapping of exhibit the effects of other orogenic formity below the Triassic here does "western facies" of Merriam and the Sonoma Range 1-degree area are episodes. Two episodes of Paleozoic not exceed about 5°, and the maxi- Anderson (1942, p. 1699), which conbeing published as four geologic orogeny are recognized, one in the mumdiscordance (Winnemucca quad-trasts with the "eastern facies" of maps, each covering a 30-minute lower-plate sequence prior to the rangle) is only about 20°. The assigndominantly carbonate rocks, widequadrangle (fig. 1). The Golconda deposition of the Pennsylvanian Bating of a Permian age to the Koipato spread over eastern Nevada. Conquadrangle forms the northeast quar- tle formation, the other in the upper- rests on the evidence of fossils from tacts of the Comus formation with ter of this 1-degree area. The topo- plate sequence within the Permian the Rochester district, 60 miles to the the overlying Valmy formation, domgraphic base is enlarged from the and older than the Koipato formation. southwest (Wheeler, 1937), but the inantly quartzite and siliceous slate, Sonoma Range topographic map ex- After the formation of the Tobin and formation is present in all the inter- show evidence of movement; but the cept for the southeast quarter, which Golconda thrusts in Mesozoic time, vening ranges. is a reduction, with some generaliza- there was a long period of erosion, tion, of the Antler Peak 15-minute after which Tertiary lavas were quadrangle. The other three 30-min- extruded. Normal faults are later The Triassic rocks of China Mounthrusting. ute geologic quadrangle maps, the than the thrusting; some were formed tain belong to the same facies which, The massive Osgood Mountain Winnemucca quadrangle on the west, before the eruption of the lavas, but in the Mount Tobin and Mount Moses quartzite generally has moderate the Mount Tobin on the southwest, most of them later. The most recent quadrangles, is characteristic of the easterly dips, but the less competent and the Mount Moses on the south, faults largely control the present upper plate of the Tobin thrust; Preble, Comus, and Valmy formawere published in 1951. For regional forms of the mountain ranges. China Mountain is the northernmost tions were highly folded and broken

relations reference is necessarily made to these quadrangles. The geologic man of the Antler Peak 15-min-

rangle; other perennial streams, confined to Battle Mountain and China of Battle Mountain, depends on min-quartzites and chert with a little slate formation.

ders of the quadrangle. GEOLOGY

quadrangles to the southwest and ing northeast and dipping to the



Pumpernickel formations are con- Havallah formations below. Al- Manhattan district 160 miles to the The rocks of the quadrangle also Triassic erosion, the angular unconformation belongs, therefore, to the

UPPER-PLATE TRIASSIC known outcrop of this facies. There by thrusts prior to the deposition of PALEOZOIC AND TRIASSIC the thinning of some formations and the lower Pennsylvanian Battle for-

an increase in the proportion of clas- mation and Highway limestone. The ute quadrangle, covering the south- More than two-thirds of the area tics as compared with the sections folded rocks generally strike north to east quarter of the Golconda quadran- of Paleozoic and Triassic rocks is farther south suggest that the section northeast; the folds are overturned gle, has been published separately on a included in the upper plate of the Golarch at China Mountain is near the north to the east. larger scale (Roberts, 1951). Detailed conda thrust. The formations of the ern or northeastern limit of deposiwork, except for the mapping of the upper plate are the units of the upper- tion of this facies. The two lowest you and Harmony formations, which Antler Peak quadrangle by Roberts, plate facies of the Triassic, the Per- formations of the Mount Tobin quad- are tentatively assigned to the Miswas confined to the mapping of the mian Koipato and the Permian (?) rangle, the Tobin and Dixie Valley, sissippian, also were strongly folded Triassic formations of China Moun- Havallah formations, and the Penn- with an aggregate maximum thick- and thrust-faulted before the depositain by Muller and of the Paleozoic in sylvanian (?) Pumpernickel formaness of 1,600 feet at their type localtion of the lower Pennsylvanian Battle the northern part of Edna Mountain tion. Below the Golconda thrust are ities, are here represented by the formation.

Helen Duncan; and those of Ordovi- thrusting, is completely different. miles to the south. On the western unknown. cian and Cambrian fossils on determi- On the upper plate, highly folded flank of China Mountain the distinc- The arkosic Harmony formation is nations by G. A. Cooper. Efficient Pennsylvanian (?) and Permian rocks tive dark bituminous limestone thins unfossiliferous, and its relation to Cambrian and Ordovician formations formation.

Edna Mountain. The formations of folds in general trend north and vary probably it is due mostly to the fact ern part of Battle Mountain.

ently are of about the same age—that above the Havallah formation. Here Paleozoic rocks show an entirely dif-

different facies. Cambrian and Ordovician.-No lowed the folding and subsequent fossils were found in the massive uplift and erosion of the underlying Osgood Mountain quartzite that formations. The formation is thickforms the lowest part of the section, est in the vicinity of Antler Peak. but the formation is probably equiv- Here it includes shale and limestone alent to other, similar quartzites, in beds, clearly of marine origin, which part possibly of Lower Cambrian (?) yielded fossils of lower Pennsylvanian (Wheeler, 1943, 1948). Lithologiand is missing in places. cally the overlying Preble formation The Highway limestone, confined

minor thrusts. Subdivision on a lith- Harmony formation. upper plate of the Roberts Mountain limestone, apparently thicker, is pres- been recognized on many ranges of percent zinc, and 3.0 ounces of silver tion in 1937 was 2,980 tons, averaging brian—Cambrian stratigraphic thrust, 80 miles to the southeast ent in the Osgood Range about 12 the Great Basin at comparable alti-(Merriam and Anderson, 1942), and that of the Toquima formation of the Moderate uplift and subsequent ginning of the Pleistocene the region on the map.

The Moderate uplift and subsequent ginning of the Pleistocene the region on the map.

The Moderate uplift and subsequent ginning of the Pleistocene the region on the map.

Silver a ton and 2.56 percent copper. In 1938, a total of 2,178 tons, averaging a contraction of the subsequent ginning of the Pleistocene the region on the map.

though there was considerable pre- south (Ferguson, 1924). The Comus movement probably is due largely to differences in competency of the two formations and is not due to major

by Ferguson. The project was under the Permian Edna Mountain forma- 500-foot, dominantly clastic China The Scott Canyon formation, conthe general direction of Ferguson, tion, the Pennsylvanian and possibly Mountain formation. This overlies sisting essentially of chert, argillite, who is also chiefly responsible for all Permian (?) Antler Peak limestone, the Koipato formation except in the slate, and greenstone, crops out only the text except those parts by Muller the Pennsylvanian Battle and High- northern part of the range where it on the south flank of Battle Mountain on the Triassic and those by Roberts way formations, the Mississippian (?) rests directly on the Havallah forma- (Roberts, 1951). Lithologically it on the ore deposits, igneous rocks, Scott Canyon, and Harmony formation, but the coarse clastics that form resembles the Pennsylvanian (?) forand descriptions relating to Battle tions, the Ordovician Valmy and its basalunit contain material derived mation of the upper plate, but it Mountain (Antler Peak quadrangle). Comus formations, and the Cambrian exclusively from the Havallah, and must be older than the Battle forma-Age assignments of Triassic fossils in Preble and Cambrian (?) Osgood it is only in the higher fine-grained tion. A lens of limestone associated this and adjoining quadrangles rest Mountain formations. Nothing is conglomerates that fragments from with pillow lava yielded poorly preon determinations by Muller; those of known of the relations of the upper- the Koipato can be identified. served sponges and algae that are the Permian and Carboniferous fos- plate formations to those below the The Favret formation does not ex- considered not older than Carbonifsils on determinations by James thrust, and the structural history of ceed 200 feet in thickness, in contrast erous. The relation of the Scott Can-Steele Williams, L. G. Henbest, and the two plates, up to the time of to 800 feet in Augusta Mountain, 40 you formation to older formations is

assistance in the field was given at are overlain by essentially nonfolded out and appears to pass into masdifferent times by J. F. McAllister, Permian volcanics and Triassic sedi- sive dolomite indistinguishable from unknown. However, in the Osgood A. E. Granger, M. P. Erickson, and mentary rocks. In the lower plate, that at the top of the China Mountains, about 12 miles north of this quadrangle, micaceous grit simi-The Golconda quadrangle is in and the two formations tentatively A dominantly clastic unit, the Pan- lar to that present in the Harmony north-central Nevada in the Basin assigned to the Mississippian were ther Canyon formation, which is not formation is in contact with metavoland Range physiographic prov- folded and thrust-faulted before the present in the Augusta Mountain and canic rocks, possibly correlative with ince and includes several small moundeposition of formations of Pennsyl- Mount Tobin sections, intervenes the Scott Canyon formation (Hobbs, tain ranges separated by desert val- vanian and Permian age. The stra- between the Favret and the Augusta 1948). The bluish cloudy quartz and leys. The maximum relief is about tigraphy and structure of the Pale- Mountain formations. Its southern- the detrital mica and feldspar of the 4,300 feet. The Humboldt River ozoic and Triassic rocks of the two most outcrop is in the northern part Harmony formation could not have crosses the northern part of the quad- plates will be described separately. of the Fish Creek Mountains, 18 miles been derived from Cambrian or Ordoto the southeast (Mount Moses quad-vician formations and must therefore rangle). On the other hand, the have been derived from a granitic or Mountain, lose their surface flow at Two thick conformable formations, limestones and dolomites of the gneissic terrane of unknown location, the mountain fronts. Two railroads the Pumpernickel and Havallah, Augusta Mountain formation, 2,500 perhaps to the west. The presence and a highway also cross the northern occupy most of the areas of outcrop feet thick in the type locality (Mount of beds of similar grit, containing part of the quadrangle, and passable of the upper-plate Paleozoic. The Tobin quadrangle), here thin to not detrital mica and feldspar, in the roads traverse the valleys. Two former contains a variable proportion more than 500 feet. An erosion intersmall settlements, Golconda and of andesitic lavas and tuffs with dark val, probably not large, is recognized mations, suggests that this terrane Valmy, are on the highway; a third, chert and argillite; in the latter, vol- between the Augusta Mountain for- was exposed to erosion, at least inter-

in Copper Canyon on the south flank canics are rare, but fine-grained mation and the overlying Cane Spring mittently, during the later Paleozoic ing in that district. Larger towns, and limestone are several thousand The Triassic rocks have an average Folds in the Scott Canyon forma-Battle Mountain on the east and feet thick. Deposition under shal- gentle easterly dip and are not folded tion in the southeastern part of Winnemucca on the west, are 4 and low-water conditions is suggested, but are broken by a large number of Battle Mountain are sheared and 12 miles, respectively, from the bor- and fusulinids in the thin limestones small normal faults, some of too broken, but most of them appear to of the lower part of the Havallah for- slight displacement to be shown on be overturned to the east (Roberts). mation, which can be referred to the map. Most of these cannot be Folds in the Harmony formation are Wolfcamp and possibly Leonard traced into the underlying, highly predominantly tight, north-trending GENERAL RELATIONS series, indicate marine deposition. folded Havallah formation. This folds. Just east of Antler Peak, the The Paleozoic and Mesozoic rocks These rocks were strongly folded may be due in part to the scarcity of major structure is a syncline, overof the quadrangle are cut by a major and thrust-faulted before the overly- identifiable key beds and to the fact turned to the east. This direction of fault, the Golconda thrust, which ing volcanic Koipato formation, also that the Havallah was not studied as overturning in the Harmony formacrops out in Battle Mountain and of Permian age, was deposited. The closely as the Triassic formations, but tion is consistent throughout the eastthe upper and lower plates of the greatly in intensity; belts of sharp that the generally steeply dipping The thrust plane on which the Harthrust are entirely different. Trias- folding, in places overturned to the Pumpernickel and Havallah forma- mony is carried above the Scott Cansic rocks and the Koipato, Havallah, east, alternate with areas of moder- tions would tend to yield along small you and Comus formations is folded

and Pumpernickel formations are ate folding. The principal belts of shears parallel to the bedding. This and broken by many normal faults. present only on the upper plate. The intense folding are in the southwest-fault pattern is characteristic of all At the northern end of the thrust the other Paleozoic formations are ern part of Battle Mountain, border- areas underlain by the upper plate of dip is about 30° to 60° E. and flattens restricted to the lower plate and are ing the outcrop of the thrust; in the the Triassic facies but is not found in southward. In the much-broken area different in the two areas where the anticline enclosing the outcrop of the the Triassic of the lower plate. It is near Little Cottonwood Canyon, outthrust is exposed. Pumpernickel formation, in the possible, therefore, that these closely crops suggest only minor warping The Golconda thrust is tentatively northern part of Buffalo Mountain; spaced small faults are related to with a general northwesterly trend. correlated with the Tobin thrust of and along the crest and east flank of movement on the thrust. The asymmetry and local eastward the Mount Tobin and Winnemucca China Mountain, where a thrust strikthe Mount Tobin and Winnemucca China Mountain, where a thrust strikthe Mount Tobin and Winnemucca China Mountain, where a thrust striksuggest that the relative movement overturn of the folds in both plates west (fig. 1). Both thrusts appar- northwest brings the Pumpernickel Below the Golconda thrust the of the upper plate may have been to is, younger than the Upper Triassic the thrust plane is overlain by the ferent stratigraphic and structural The amount of movement on this formations and older than the gra- Permian Koipato formation. sequence from those of the upper thrust is unknown, but as completely

nitic and porphyritic intrusives of China Mountain is, as far as known, plate. Triassic rocks of the lower-different formations are superposed Jurassic or later age. There are, the eastern limit of the Koipato for- plate facies do not crop out in this it must have been considerable. however, some differences in the rela- mation. Rhyolite, with andesite near quadrangle. The younger pre-Trias- Pennsylvanian and Permian. tions of the two thrusts. The Tobin the base, has a maximum thickness sic formations are of Permian and Above the highly folded rocks of thrust has Upper Triassic rocks of of about 400 feet on the western flank, Pennsylvanian age; they unconform- Cambrian to Mississippian (?) age is different facies on the upper and low- but to the north and east it was com- ably overlie Cambrian and Ordovician a sequence of formations that range er plates, but both plates contain pletely eroded prior to the deposition formations in Edna Mountain and in age from lower Pennsylvanian to folded rocks of the Havallah and of the Triassic rocks. Structurally Ordovician and Mississippian (?) for- Permian. These lack the intense Pumpernickel formations. The Gol- the formation is more in accord with mations in Battle Mountain. folding that affected the underlying conda thrust cuts Paleozoic forma- the overlying Triassic than with the In contrast to the Permian folding rocks and are also essentially free of tions only, and the Havallah and faulted and folded Pumpernickel and of the upper-plate rocks, the Penn- the folding of early Permian age sylvanian and Permian formations of shown by the Havallah and Pumperthe lower plate are only locally folded nickel formations of the upper plate but overlie highly folded older rocks. of the Golconda thrust. This folding, prior to the deposition The coarse conglomerates of the of the Pennsylvanian Battle forma- lower part of the Battle formation tion, was accompanied by thrusting near Antler Peak indicate at least of sufficient magnitude to involve local steep topography and suggest

that deposition may have closely fol-

Cambrian from other areas. The garded as an offshore facies contemonly fossil, Lingula, found more than poraneous with the upper part of the halfway above the base, indicates Battle formation at Antler Peak. Middle or Upper Cambrian age. As Both the Battle formation and estimated from the outcrop of the Highway limestone are lacking farsteeply dipping beds, the formation ther to the west; on the west flank has an apparent thickness of more of Edna Mountain the overlying Antthan 12,000 feet. Possible duplication ler Peak limestone rests on Cambrian due to isoclinal folding cannot be rocks, and in the Sonoma Range excluded; on the other hand, there is (Winnemucca quadrangle) the Antler some suggestion of telescoping by Peak limestone overlies the folded ologic basis probably would be pos- In Battle Mountain the Antler Peak sible by more detailed study, with limestone overlies the Battle formathe lower third, which contains the tion conformably, but on Edna Mounlimestone lenses, separated from the tain some erosion of the underlying overlying predominantly slaty part. Highway limestone is suggested by The Comus formation is composed the presence of a few feet of lime- rolling surface with a relief of about foot level is in the hornfels. The ore in mineralogy and grade to those of dle Cambrian stratigraphy in the essentially of chert, siliceous slate, stone conglomerate at the base of the 1,000 feet; on China Mountain the minerals are principally argentiferous the Sweet Marie. and minor quartzite and limestone. Formation. Pebbly layers through- horizontal strata accentuate a flat galena, sphalerite, pyrrhotite, and Carissa mine.—The Carissa mine.—The Carissa mine America Bull., vol. 54, pp. 1781-Its lithology somewhat resembles out the Antler Peak limestone sugthat of the Vinini formation of the gest near-shore deposition. Similar upland surfaces have is reported to be 2.3 percent lead, 1.5 yielded copper-gold ore. The produc-

are shown by the unconformable 3,000 or 4,000 feet, with external (2), a half mile southeast of the Cop-shipped. The mine is within the overlap of the Permian Edna Moun- drainage, and that widespread uplift per Canyon mine, has been worked Harmony formation, which is here sist of pebbles derived from both the feet. Cambrian and Edna Mountain forma- The Humboldt River is an antece- boy mine.

exposed to erosion. MESOZOIC INTRUSIVES The largest outcrop of intrusive Lahontan entered the area only in the Canyon mine in the Antler Peak lime- Valley mine (9), on the west flank of rocks is that of Buffalo Mountain, extreme northwest corner of this stone (Hill, 1915, p. 89). The ore the range, has been operated interwhere coarsely crystalline granodio- quadrangle. Beaches of a probably consists of iron oxides, anglesite, and mittently. One lot of 1,060 tons shiprite has an irregular border facies contemporaneous lake are well pre-cerussite in a zone that strikes N. 15° ped is said to have contained 0.695 ranging from gabbro to diorite. Sim- served in Buffalo Valley just south of W. and dips 50° SW. ounce of gold and 1.88 ounces of sililar masses on the east flank of the the quadrangle.

faults that are later than the Gol- the lake antedated the rock cutting reported.

Mountain mass also crop out farther northward to Golconda, and of a Nevada. size to the margin of the Sierra falo Valley by drainage flowing into of Battle Mountain, which cut the end of this valley. Golconda thrust, may be related to the Buffalo Mountain intrusives or may be somewhat younger.

flows on the west flank of Osgood

partly Pleistocene. NORMAL FAULTS Normal faults probably have been (Roberts, 1951).

tiary lavas and has continued to the Copper Canyon on the southern flank the Iron Canyon mine massive sulfide tions that rose along the faults and but the difference in fault pattern is reported as 42,000 tons of highpre-Tertiary age.

and can be inferred from the steep- levels and are vertical or overturned briefly.

tain formation, which contains a was concomitant with development intermittently since 1900. In 1948 altered to tactite and hornfels. The strata. Basal conglomerates are cated by the rock-cut benches, partly the lower chloritic conglomerate of and native gold.

not more than 2 feet thick and contudes of about 6,500 and about 5,000 reported at the Chessher-Indepentions. Local relief on the pre-Edna dent stream, transverse to structure, Independence mine.—The Indepen-Mountain surface is indicated by the which has held its course from an dence mine (3) is a half mile southpresence of a fanglomerate at the early stage in the cycle. At present west of the Copper Canyon mine. copper minerals have been explored base of this formation in the Osgood the river is at grade and wanders The workings explore a fault zone in the Bannock and Elder Creek area, Mountains a few miles north of the through a meander belt more than 2 that strikes north and dips steeply to but only a small tonnage has been quadrangle (Hobbs, 1948). Within miles wide, bordered, except in Emi- the west in shale and chert of the produced. the formation a few beds of micace- grant Canyon, by low banks cut in Pumpernickel formation. Gold-silver Marigold mine.—The Marigold ous grit similar to that of the Har- the valley fill. West of Emigrant ore valued at about \$200,000 has been mine (8), near the northern end of mony formation indicate that a gra- Canyon, relatively recent aggrada- mined from an ore shoot 400 feet long the range, has yielded several thounitic or gneissic terrane was again tion is indicated by wells reported to that extends about 160 feet below the sand tons of siliceous gold ore reported have reached a depth of more than surface. 200 feet in river gravels and sand. Nevada mine.—The Nevada mine ton. The waters of Pleistocene Lake (4) is a half mile north of the Copper Buffalo Valley mine.—The Buffalo

> Placer deposits.—Placer deposits ver a ton. There is also the trace of an old beach come from areas at the mouths of aging 30 percent manganese.

ECONOMIC GEOLOGY workings are now caved and are inac- in quartz gangue. deposits have been exploited in the

topographic form of the range. The 1939 and 1946. planes. relatively fresh and less deeply eroded

relatively fresh and less deeply eroded

BATTLE MOUNTAIN

Other prospects.—The Dattle Golconda, has yielded a notable Mountain, Avalanche, Driscoll, and Golconda, has yielded a notable Mountain may be younger. On the The Battle Mountain district in- Trinity veins east of Galena strike amount of tungsten, chiefly between basis of similarity to other parts of cludes the Copper Canyon, Copper north and dip 45° to 60° W. They are 1941 and 1945 (Pardee and Jones, 1919, Nevada, it is inferred that the rhyo- Basin, Galena Canyon, Elder Creek, similar in mineralogy to the White pp. 231-238, Kerr, 1940; Roberts and lite may be of Miocene age and that Bannock, and Buffalo Valley areas of and Shiloh veins. the basalt may be partly Pliocene and Battle Mountain. The mines are The Plumas, Gold Butte, Iron Canciated with manganese and iron more fully described in the text yon, and Buzzard veins farther east oxides were interbedded with alluaccompanying the geologic map of are in chert and argillite of the Scott vium on the north flank of Edna the Antler Peak quadrangle Canyon formation. All the veins fol- Mountain. Lenticular ore bodies are formed during all the orogenic epicopper canyon area

addition to the minerals present in the White and Shiloh veins, pyrrhotite and for a width of as much as 1,800 the White and Shiloh veins, pyrrhotite and for a width of as much as 1,800 the White and Shiloh veins, pyrrhotite and for a width of as much as 1,800 the White and Shiloh veins, pyrrhotite and for a width of as much as 1,800 the White and Shiloh veins, pyrrhotite and for a width of as much as 1,800 the White and Shiloh veins, pyrrhotite and

of Battle Mountain, has been the ore bodies 20 feet thick have been flowed down the slepes; tungsten-No faults can be definitely proved most productive property in the quadto be earlier than the Tobin thrust, rangle. Production from 1866 to 1880

COPPER BASIN AREA in the alluvium along with the from and manganese oxides. The ore in above and below the thrust on Battle grade ore; from 1916 to 1918 the out- The Copper Basin area has been places contained as much as 2.5 per-Mountain suggests that such an early put was 22,487 tons, averaging 9 persporadically productive since the cent WO<sub>3</sub> but averaged less. The date may be possible for some of the cent copper. Production was spo- 1860's. Copper, copper-gold, and sil- ore bodies mined ranged from 1 foot faults that cut the Harmony and radic during the 1920's and 1930's, ver-lead-zinc ores have been mined to 20 feet in thickness. Scott Canyon formations below the but in 1941 a 350-ton mill was built, in the area, but the copper ores have thrust. As noted above, the closely and to the end of 1945 nearly 400,000 accounted for the greatest output spaced faults, with small displace- tons of copper-gold ore had been thus far. The copper ore bodies that ments, that cut the Triassic of China treated from ore bodies above the have been mined are enriched ores Ferguson, H. G., 1924, Geology and Mountain may be associated with 500-foot level. In 1948 development containing chalcocite, cuprite, and ore deposits of the Manhattan dismovement on the Tobin thrust. work was extended to the 700-foot locally copper carbonates and chryso- trict, Nev.: U. S. Geol. Surv. Bull. Some of the normal faults of Bat- level to mine a lead-silver-zinc ore colla. The copper-gold ore bodies 723. tle Mountain cut the Tobin thrust; body discovered by drilling. contain chalcopyrite, pyrite (locally Hill, J. M., 1915, Some mining disothers, by the minerals deposited The mine workings are principally oxidized), and native gold, which realong their planes, clearly indicate a in the Battle formation, which here place calcareous beds in the Harmony S. Geol. Surv. Bull. 594, pp. 64-91. consists of a lower conglomerate with formation. The silver-lead-zinc ores Hobbs, S. W., 1948, Geology of the The present ranges are in large matrix and some pebbles replaced by are found in quartz veins containing northern part of the Osgood Mounpart bordered by faults on which a chlorite, a middle hornfels, and an galena, sphalerite, pyrite, arsenopy- tains, Humboldt County, Nev. certain amount of recent movement upper quartzitic conglomerate. rite, and locally tetrahedrite. (manuscript report in files of U. S. is proved by gravel scarps parallel These rocks strike north and dip A typical mine of each of these Geol. Survey). and close to the principal fault plane steeply to the west on the upper three major groups is described Kerr, P. F., 1940, Tungsten-bearing

ness of the fans bordering the range to the east on the lower levels. The Sweet Marie mine.—The Sweet Nev.: Geol. Soc. America Bull., front. That faulting is still in prog- ore bodies lie between two parallel Marie mine (6), in the central part of vol. 51, pp. 1309-1389. ress is shown by the small scarp, 2 or faults, about 800 feet apart, which the district, is typical of the copper Merriam, C. W., and Anderson, C. 3 feet in height, that developed along strike north and dip 65° W. mines and has a recorded production A., 1942, Reconnaissance survey of the west flank of China Mountain Oxidized copper ore bodies, consist- of 20,071 tons of ore that averaged the Roberts Mountains, Nev.: Geol. during the 1915 earthquake. In the ing principally of chrysocolla, azurite, 9.99 percent copper. The workings Soc. America Bull., vol. 53, pp. adjoining Mount Tobin quadrangle and malachite, were mined near the are in argillite, largely altered to 1675-1728. the earthquake displacement reached surface and to a depth of 50 feet. hornfels, and in sandstone of the Pardee, J. T., and Jones, E. L., Jr., a maximum of 16 feet. Battle Moun- Enriched ore bodies extended below Harmony formation, which have been 1919, Deposits of manganese ore in tain, China Mountain, and Buffalo the oxidized ore to the 300-foot level intruded by porphyry dikes. These Nevada: U. S. Geol. Survey Bull. Mountain are bounded by steep slopes and locally lower; cuprite and chal-rocks have been broken by two main 710-F, pp. 209-241. age, that form the lowest unit of the (Des Moines) age. Elsewhere the that have the appearance of fault cocite replace pyrite in veins and sets of faults, an older set striking Roberts, R. J., 1951, Geologic map of Paleozoic section in much of Nevada formation is not over 100 feet thick scarps. There is some evidence, how- are disseminated throughout the about N. 60° to 70° E. and dipping the Antler Peak quadrangle, Nev.: ever, that these steep range fronts hornfels. 25° to 45° NW. and a younger set U. S. Geol. Survey. Geol. Quad. in part may be due to erosion of The primary (hypogene) copper- striking N. 60° to 70° W. and dipping Map Ser. does not closely resemble the known to the Edna Mountain area, is re- less resistant, down-faulted forma- gold ore bodies are veins and dissem- steeply. Both sets of faults are Roberts, R. J., and Albritton, C. C., tions such as the Tertiary tuffaceous inations of pyrrhotite, arsenopyrite, mineralized, but commonly the richchalcopyrite, galena, sphalerite, mar- est ore is along faults of the older set, conda, Nev. (U. S. Geol. Survey Maximum displacement along two casite, pyrite, and locally molybde- which controlled the downward move- press release). frontal faults where the down-thrown nite. The gangue minerals are ment of solutions during oxidation Schrader, F. C., 1932, The Battle block is exposed, on the east front of quartz, calcite, and siderite. Metal- and enrichment. Mountain mining district, Nev. China Mountain and the west front ization is confined principally to the In the upper workings the ore was (manuscript report in files of U. S. of Battle Mountain, exceeds 1,500 lower chloritic conglomerate, but the mainly copper carbonates and chryso- Geol. Survey), pp. 1-155.

upper conglomerate is mineralized colla, but in the lower levels chalco- Vanderburg, W. O., 1939, Reconnais-DEVELOPMENT OF locally along faults. The tenor of cite was the predominant mineral. sance of mining districts in Lander PRESENT TOPOGRAPHY
the ore mined on the upper levels ranged from 1.0 to 4 percent copper 245 feet long, 110 feet wide, and 50
The largest ore body discovered was ranged from 1.0 to 4 percent copper 245 feet long, 110 feet wide, and 50
Inf. Circ. 7043, pp. 1–83. Remnants of an old topography, and averaged 0.10 ounce of gold to feet thick. Only the richer and eas- Wheeler, H. E., 1937, Helicoprion in possibly dating from the close of the the ton. On the lower levels the copily accessible parts of the ore bodies the Anthracolitic (late Paleozoic) Tertiary, are preserved on the crests per content decreased to 0.5 percent have been mined. of Battle Mountain and China Moun- or less, but the gold content remained The Copper Queen, Contention, significance: Jour. Paleontology, tain at altitudes of 7,500 or 8,000 feet. about the same. Widow, and Chase mines also have vol. 13, pp. 103-114. On Eattle Mountain there is a gently The lead-zinc ore body on the 700- produced enriched copper ores similar Wheeler, H. E., 1943, Lower and Midplateau broken by sharp steps along pyrite. The average tenor of the ore (7) is typical of the mines that have 1822.

erosion of the Antler Peak limestone was one of moderate relief, perhaps Tomboy mine.—The Tomboy mine ing 0.34 ounces of gold a ton, was fauna of Phosphoria age. On the of the present valleys both by erosion the mine was reopened and the ore ore formed a tabular body 4 to 15 north flank of Edna Mountain, the of old fault basins, formed during an trucked to Copper Canyon for mill feet thick, bounded by faults; it has Antler Peak limestone was complete- earlier cycle, and by renewed down tests. The ore is similar in mineral- been stoped down dip for 150 feet ly eroded and the Edna Mountain for- faulting along earlier-formed faults. ogy to the copper-gold ore at Copper over a length of 60 feet. The ore mation rests on upturned Cambrian Pauses in this process may be indipresent in places but generally are gravel-covered, most common at alti- the Battle formation. Similar ore is The Surprise and Copper King dence mine, a mile north of the Tom- gold ores similar to the Carissa ores.

Sonoma Range are part of a larger Traces of a probably older lake in the Battle Mountain district (Van- Black Rock mine.—The Black Rock mass that extends west into the were found at an altitude of about derburg, 1939) have been mined since manganese mine (10), on the west Winnemucca quadrangle; other 4,500 feet south of Thomas Spring, 1890 in Copper Canyon, Copper Basin, flank of the range, was operated from masses in the southern part of Edna on the ridge northwest of Valmy, and Galena Canyon, Iron Canyon, and Box 1941 to 1944. The recorded produc-Mountain cut the plane of the Golon Treaty Hill, north of the river. Canyon. The principal output has tion is about 2,000 tons of ore, aver-The smaller intrusive masses of at a higher elevation in the valley of Copper Canyon and Box Canyon, a The ore consists of psilomelane, Battle Mountain consist dominantly the Reese River, south of the quad-mile to the east of Copper Canyon. wad, and pyrolusite which replace of granodiorite and quartz monzonite rangle. The beach remnants are well The gold ranges from 830 to about 900 chert and shale of the Havallah forporphyry. The southern and west- above the present surface of Emi- fine and is generally coarse; nuggets mation. Three principal ore bodies ern masses cut the planes of normal grant Canyon, but it is unlikely that as large as 5 ounces have been have been explored; the largest was 420 feet long and as much as 21 feet of the canyon. Possibly the lake was In 1946 the Natomas Co. acquired wide, extending down dip for 40 feet. The intrusives are later than the formed following an arid period when the Copper Canyon fan area and in Other deposits.—Other manganese Golconda and Tobin thrusts, but there waste from the bordering hills formed 1947 began large-scale operations. deposits are known in the Buffalo is no direct evidence of the date of a temporary dam in the canyon. The company plans to dredge an enor- Range and the southern part of Edna intrusion. Masses of coarsely crys- Changes in valley topography now mous yardage of the fan gravels and Mountain. As the deposits are small talline intrusive rocks with mafic bor- in progress include the capture of the gives promise of being one of the and the ore is siliceous, the deposits ders such as those of the Buffalo southern part of the valley, draining major placer operations in central have not been worked (Pardee and Jones, 1919, pp. 235-241).

Nevada batholith about 75 miles to Pumpernickel Valley. The partial The Galena Canyon area, 2 miles Canyon, has yielded a few hundreds the west. It is therefore possible stripping of the fill in the northern north of Copper Canyon, was active of tons of antimony ore. The workthat these are satellitic to the Sierra part of Buffalo Valley, exposing between 1868 and 1885 and has been ings are in and near a fault zone that Nevada batholith and, if so, possibly small areas of bedrock, may be due intermittently active since then. strikes N. 15° E., dips 55° to 70° NW., of late Jurassic age. The intrusives to recent depression of the southern The estimated production, chiefly in and cuts argillite and chert of the gold, silver, and lead, is valued at 3 Scott Canyon formatiou. The ore is to 6 million dollars. Most of the stibnite with some antimony oxides Gold, copper, silver, lead, and zinc cessible, and much of the following GHINA MOUNTAIN Golconda quadrangle since 1866 (Hill, (1915) and Vanderburg (1939). Silver-Lead mine.—The Silver-Small areas are underlain by rhyo- 1915, p. 71; Schrader, 1932, pp. 1-83). White and Shiloh mine (5).—The Lead mine (12), on the eastern slope lite and basalt in Battle and Edna The principal producing areas are at White and Shiloh workings at Galena of China Mountain, has been inter-

Mountains and by basalt in Osgood Copper Canyon and Copper Basin, in explore fault zones that strike north mittently active since the 1880's, but Mountain. Obviously a long period the Battle Mountain district in the and dip steeply to the west in the production has been small. The ore of erosion preceded their outflow. southeastern part of the quadrangle. Harmony formation and along its is galena, sphalerite, and pyrite in The rhyolite is the older of the two Antimony and manganese deposits in contact with the Battle formation. lenticular veins along faults striking and is separated from the basalt by nearby areas have been worked inter- The ore, composed of sphalerite, ga- north and dipping 60° to 70° W. considerable erosion interval. At mittently, and silver-bearing lead ore lena, pyrite, and tetrahedrite in a Near the surface the galena is altered Battle Mountain the relation of the has been mined on the east flank of gangue of quartz and calcite, replaced to cerussite. basalt to erosional features suggests China Mountain. A tungsten deposit crushed rock in the fault zones and EDNA MOUNTAIN that it may be older than the present near Golconda was worked between locally extended out along bedding rungsten deposit.—The Golconda Other prospects.—The Battle tungsten deposit (13), 3 miles east of

low north-trending fault zones. In alined along faults that trend northaddition to the minerals present in northeast for a length of 4,800 feet region, but the major period of nor- Copper Canyon mine.—The Copper and arsenopyrite are locally promi- feet. Presumably the tungsten ore mal faulting was later than the Ter- Canyon mine (1)1, near the mouth of nent constituents of these veins. At was derived from hydrothermal solu-

0.62 ounce of gold and 2.44 ounces of cross section through southern

to contain 0.2 to 0.5 ounce of gold a

west; they increase in number and small area at the northern end of Buf-

Albritton, 1943). Tungsten ores asso-

REFERENCES manganese deposit at Golconda,

Great Basin area: Geol. Soc.

is, desert wash; stream gravels; silts and clays along the Humboldt River; aches and deposits of Lake Lahontan in northwest and an unnamed Pleistocene GEOLOGY OF THE DEPARTMENT OF THE INTERIOR GOLCONDA QUADRANGLE UNITED STATES GEOLOGICAL SURVEY W. E. WRATHER, DIRECTOR Older gravels (Osgood Mountains 1:62500) Gravels of older erosion stages. Mapped only in par UNCONFORMITY Rhyolite flows and tuff MAJOR UNCONFORMIT UPPER PLATE OF GOLCONDA THRUST LOWER PLATE OF GOLCONDA THRUST Cane Spring formation Augusta Mountain formation vive gray limestone and dolomite with some intercalated shale. This v, 300 to 400 feet; 2,500 feet at type locality, Augusta Mountain ut Tobin quadrangle Panther Canyon formation Ryegrass Ranch Favret formation China Mountain formation Koipato formation Edna Mountain formation MAJOR ANGULAR UNCONFORMIT Havallah formation Pumpernickel formation k chert and dark siliceous argillite with intercala eenstones. Base not exposed. Thickness proba ceeds 6,000 feet. Named from Pumpernickel Val BASE CONCEALED MAJOR ANGULAR UNCONFORMITY MAJOR ANGULAR UNCONFORMITY SEQUENCE UNKNOWN Geology mapped in 1939-41 Base map for southeast quarter reduced and generalized from Geology of the southeast quarter ntler Peak quadrangle generalized from a more detailed opography by R. W. Burchard and map of the Antler Peak quadrangle A. Fankhauser, 1940 by Ralph J. Roberts Remainder of map enlarged from Sonoma Range quadrangle opography by R. C. Seitz, 1931-32 teeth indicate upper plate. Faults dashed where sketched in part or adjusted topography; probably essentially accurate. Dotted where sketched, inferred, or cealed; may be inaccurate SECTION ALONG LINE B-B' HORIZONTAL AND VERTICAL SCALE OF STRUCTURE SECTIONS 2 TIMES SCALE OF MAP Generalized strike and dip of gently dipping beds Generalized strike and dip of steeply dipping beds GEOLOGIC MAP Generalized strike and dip of gently dipping overturned beds GOLCONDA QUADRANGLE, NEVADA Generalized strike and dip of steeply dipping overturned beds By H. G. Ferguson, Ralph J. Roberts, and S. W. Muller Strike of vertical beds Scale 1:125,000 1 ½ 0 1 2 8 4 5 Miles Prospect APPROXIMATE MEAN DECLINATION, 1951 Contour interval 100 feet Datum is mean sea level 1952