GEOLOGY OF THE MOUNT TOBIN QUADRANGLE, NEVADA By S. W. Muller, H. G. Ferguson, and Ralph J. Roberts

this is one. For regional relations table. mapping; detailed work was largely Ranges.

with the field work for part of one Prida with a part of the Favret for- ammonites as Acrochordiceras, along the west front of the Tobin season, and efficient assistance in the mation of the upper-plate facies. The Guccoceras, and Balatonites. Range. field was received at different times C. trinodosus zone apparently reprefrom J. F. McAllister, A. E. Granger, sents a widespread inundation of an tributed throughout the 800 feet of M. P. Erickson, and J. L. Rich. The uneven bottom of a shallow sea and interbedded dark bituminous shales The Inskip and Leach formations text has been critically reviewed by lasted only a relatively short time; and limestones of the Favret forma- of the East Range were folded prior P. B. King, and his many valuable locally it produced a deposit only a tion, indicate that relatively uniform to the deposition of the Koipato forsuggestions for improvement of few tens of feet thick. conditions were widespread and prearrangement and expression have The Middle Triassic Natchez Pass vailed throughout a considerable part the Winnemucca quadrangle, an un-Much of the geology of the low hills the Prida formation, consists domi- including the time represented by the cuts out nearly the entire thickness west of Goldbanks is taken from a nantly of massive dolomites, in part Nevadites fauna. The lithology and of the Inskip formation. The westmap by R. M. Dreyer (1940). secondary, and limestones. Lenses fauna of the Favret formation, par-The Mount Tobin quadrangle is in of conglomerate containing pebbles ticularly the Geratites trinodosus northwest corner of the quadrangle north-central Nevada, within the of the Koipato and older formations, assemblage, are also recognized in continues north and is represented Basin and Range physiographic prov-sandstone and silicified slate, indicate the Prida formation of the lower-plate by overturned folds in the Triassic ince, and consists of longitudinal sporadic oscillations. mountain ranges which rise to max- The succeeding Upper Triassic correlation of the two facies. But in in the syncline south of Leach Canimum altitudes of more than 8,000 Grass Valley formation is composed China Mountain (Golconda quadran- you is not represented in the Triassic feet. The intervening desert valleys dominantly of shales and quartzitic gle), a few miles to the northeast, rocks. are on the average 4,000 feet above sandstones. Abundance of ripple limestones and shales of the Favret The Koipato and Triassic formasea level. Generally passable roads marks, channeling, cross bedding, formation pass laterally into coarser tions of the upper-plate facies of the connect the area with the nearest and rill marks, as well as the lentic- clastic, near-shore sediments, the Tobin thrust are, on the other hand, towns on the railroad and highway ularity of intercalated units, speaks Panther Canyon formation. essentially free of folding; hence Winnemucca is about 33 miles north for shallow-water conditions. The Conformably above the Favret structures belonging to the Permian

Golconda thrust of the Golconda Fossiliferous limestone lenses are offshore deposits. Following a long period of erosion sand (calcarenite).

to this faulting. Continental sedi- ate deposition to one in which varied and below the lowermost part of the phoria formation. Therefore availments of Tertiary and Pleistocene age types of clastic sediments were de- Upper Triassic Trachyceras aon zone. able paleontologic determinations were deposited in the intermontane posited. The shallow-water environ- The conformably overlying Cane assign this period of orogeny and PALEOZOIC The oldest stratigraphic units of Triassic is abundantly evinced by the Augusta Mountain formation by a Paleczoic age in the quadrangle, the ripple marks, cross bedding, and biothinly bedded limestone near its base. Pennsylvanian (?) Leach and Pumper- clastic make-up of some of the More massive carbonate rocks are formation is more closely allied with nickel formations, consist largely of carbonate beds containing recogniz- present in the upper part. A few the Triassic than with the underlying metavolcanics, with interbedded able spines of a Gidaris-like echinoid. poorly preserved fossils from the Permian (?) and Carboniferous forchert, phyllite, and slate. These two Temporary withdrawal or local drying Cane Spring formation ("Gardita" mations, but a major erosional unformations may be correlative with up of the water in which the sedi- sp., Alectryonia sp.) place it in the conformity below the Triassic is each other, but as the conformably ments were laid down is shown by Upper Triassic, most likely Karnian. everywhere evident, and angular overlying formations are lithologi- mud cracks in fine shales and by well- The formation is probably of discordance to a maximum of about cally different, it is thought best to preserved amphibian footprints. shallow-water origin. treat them as separate units until Petrified logs of Araucarioxylon ari- The youngest Triassic formation of JURASSIC FOLDING AND their regional relationship is better zonicum interbedded in marine shales the upper-plate facies, the Osobb understood. The Permian(?) Inskip and dolomites imply proximity to escrops out only in the East Range be- tuaries through which the driftwood massive dolomites of the Cane Spring orogeny is the Tobin thrust, which is low the Tobin thrust, but the Haval- from nearby forest-clad land found formation. The contact between the recognized over a large part of the lah, though principally present in the its way into the seas or lagoons. dominantly carbonate deposits of the Mount Tobin quadrangle and probably upper plate of the Tobin thrust, is Upper-plate facies.—The Lower Cane Spring formation and the clastic parts of the Winnemucca, Golconda, also present below the thrust in the and Upper Triassic sections in the sediments of the Osobb formation is and Mount Moses quadrangles as well. southern part of the Tobin Range. upper-plate facies above the Tobin sharp. At the base the Osobb con-The Inskip contains a greater pro- thrust are characterized by thick and tains calcareous shales which grade normal fault, dips to the south in the portion of graywackes and conglom- predominantly clastic sediments, upward into beds of cross-bedded southern part of the Tobin Range. erates than the Havallah. Both whereas the Middle Triassic section sandstone, shale, bioclastic limestone, There must, however, be a northern overlie formations of similar litholis predominantly carbonate rock. In and dolomite. The formation representations of similar litholis predominantly carbonate rock. ogy, and it seems likely that they the upper-plate facies the Lower and sents a shallow-water deposit with tiary lava of Golconda Canyon, for to may be contemporaneous. The Per- Middle Triassic sections appear to oscillating environmental conditions. the north (Winnemucca and Golconda mian(?) Inskip may represent mar- represent a more complete record The age is late Triassic, probably quadrangles), the Paleozoic rocks are ginal facies of the more widespread than the corresponding sections in Karnian. Havallah. Such paleontological the lower-plate facies. evidence as could be obtained does The base of the Lower Triassic not contradict this interpretation. Tobin formation, the lowest Triassic The Mount Tobin quadrangle is in to the East Range, as is indicated by The only determinable fossils in the unit of the upper plate, is generally a region which, during Paleozoic and the presence of the upper-plate Tobin Havallah formation, fusulines from marked by a variable thickness of Mesozoic time, was subjected to oro-formation on the east flank south of

Series

LOWER Scythian

formations were intensely folded and deeply eroded before the deposition of the dominantly volcanic Koipato formation. The Permian age of this formation has been determined by Wheeler by the discovery of Helicoprion in bedded rhyolitic tuff from the Rochester district in the West Humboldt Range, 8 miles west of the western border of the quadrangle (Wheeler, 1937). In the East Range the Koipato rests on the Leach formation, which indicates erosion of the entire thickness of the Inskip formation; in the Tobin Range the Koipato overlies the Havallah formation on both plates of the thrust. The thickness of the Koipato formation in this quadrangle is only a fraction of its thickness in the West Humboldt Range, where Knopf (1924) estimates 10,000 feet of rocks about equally divided between lavas, tuffs, and breccias. In the East Range, at the northern border of the quadrangle, there is only a few hundred feet of Koipato between the Leach and Triassic formations. In the Tobin Range the Koipato of the lower plate was completely eroded locally before Triassic deposition, but in the upper 2,000 feet in places and is largely conglomerate with interbedded tuff. To the north, however, in the Winnemucca and Golconda quadrangles, the Koipato of the upper plate is thin and locally lacking.

TRIASSIC Two distinct lithologic and faunal facies of the Triassic rocks are present above and below the Tobin thrust. Clastic sediments interpreted to be of shallow-water environment are common in the lower-plate facies, whereas the upper-plate facies contains a Permian larger proportion of the carbonate

reference is made to the adjoining Lower-plate facies. —In this quad- Tobin formation was abruptly fol- the East Range.

formation, which is conformable on of the Middle Triassic-up to and conformable overlap of the Koipato

by thrusts before the deposition of deposition of the Dun Glen formation, brachiopods, and occasional nauti-

each plate. Movement on the Tobin stones with only thin lenses of new and do not permit the precise of the two small thrusts and is tracethrust occurred probably during Ju- sandstone and shale. dating of the formation, but it is prob- able across the range to China rassic time but prior to the intrusion Weathered surfaces of massive ably of late Middle Triassic age, Mountain in the Golconda quadrangle, of the principal masses of granitic dolomite beds locally show cross bed-perhaps Upper Triassic near the top. where it is overlapped by the Koipato rocks, which are believed to be satel- ding, which suggests that the original The Middle Triassic age of some formation. lites of the Sierra Nevada batholith. sediment was probably a carbonate fossils of the Augusta Mountain formation may be deduced from the fact mined in the Golconda quadrangle is came the outflows of Tertiary lavas. Shales and sandstones interbedded that in the New Pass area, 20 miles of Permian (?) age (Wolfcamp and Contemporaneous with and later than with dolomites and limestones, which south of the Tobin quadrangle, simithis volcanism was large-scale normal constitute the next younger Winne- lar species of brachiopods and pele- Wheeler (1937), Helicoprion, which faulting. The present mountains mucca formation, indicate change cypods occur above the middle determines the Permian age of the owe their relief directly or indirectly from a period of dominantly carbon- Triassic Geratites trinodosus zone Koipato, is also present in the Phosment during the deposition of the Spring formation is clearly separated extensive erosion within the Permian.

STRUCTURE Battle Mountain in the Golconda conglomerate, locally fanglomerate, genic movements whose extent is not Kennedy, but owing to a probable

Lower-plate facies

WINNEMUCCA FORMATION

Araugarioxylon arizonigum

"Cidaris" spines

Myophoria sp.

Trichites sp.

PRIDA FORMATION

Geratites trinodosus

KOIPATO FORMATION

rocks, presumably of offshore charac- suggests a shallow-and perhaps brack- nian sediments. Within the Mount the basalt. ter. In the lower-plate facies 80 ish-water environment. Several Tobin quadrangle, rocks of the upper In the Stillwater Range, close to form the frontal faults which outline which suggests a displacement in between 1894 and 1905; since then The geologic map of the Mount percent or more of the Triassic sechorizons throughout the section conplate of the Tobin thrust were folded Tobin quadrangle, Nev., is part of a tion is Upper Triassic, but in the tain poorly preserved ammonites. and thrust during the Permian. After project for the study of the Sonoma upper-plate facies the Lower, Middle, Other forms provisionally identified these movements, presumably during Range degree sheet. The preliminary and Upper Triassic rocks are of nearly from the Tobin formation are Glaraia the Jurassic, two thrust faults deresults of this work are published as equal thickness. Approximate cor- sp. cf. C. aurita, Subcolumbites sp., veloped, the Tobin thrust (fig. 1) and four 30-minute quadrangles, of which relation is shown in the accompanying Myophoria sp., and Hungarites (?). a later thrust which is believed to certainty but may be the Favret and quence of the upper-plate facies in was movement to a maximum of 5 granite, quartz monzonite, granodio-The deposition of the shales of the have overridden the Tobin thrust in

Winnemucca (N.), Golconda (NE.), rangle all Triassic units in the lowed by the accumulation of coarse The igneous rocks of the East and and Mount Moses (E.) quadrangles. lower-plate facies except the upper- clastic debris, conglomerate and Stillwater Ranges, with the possible Field work during 1939-41, with most formation, the Raspberry for- grits, interbedded with shaly or sandy exception of the earlier alaskite in additional study in 1945 and 1947, mation (Winnemucca quadrangle), dolomite and some limestone, consticombined detail and reconnaissance crop out in the Stillwater and Tobin tuting the Dixie Valley formation. the folding of the pre-Tertiary rocks. The uppermost 50 feet of the Dixie These intrusives appear to be eastern confined to areas of structural and The lowest Triassic unit of the Valley formation consists dominantly satellites of the Sierra Nevada bathstratigraphic complexity, chiefly lower-plate facies, the Prida forma- of yellow-to reddish-brown dolomites olith and are regarded as of probable those underlain by Triassic rocks. tion, is unconformable on the Koipato interbedded with shales and some late Jurassic age, although the evi-The project was under the general formation. A basal conglomerate is limestone. The change in lithology dence does not preclude a later age. direction of H. G. Ferguson, who is followed by impure dolomites inter- from coarse clastic sediments to caralso largely responsible for the text. calated with shale and some bonate rocks presents a gradual after intrusion of the igneous rocks S. W. Muller is responsible for the sandstone, which pass upward into transition to the overlying Favret have displaced the thrusts and folds. descriptions of the Triassic formadark bituminous shales and thinly formation. No fossils were found in Faulting continued into the present tions and for identification of the bedded shaly limestones. The am- the Dixie Valley formation, but there topographic cycle and to a variable Triassic fossils; Ralph J. Roberts, monite assemblage from the black is little doubt that it is uppermost extent is directly or indirectly refor study of the ore deposits and ig- shales and limestone indicates the Lower Triassic in age, as the con- sponsible for the present relief of the neous rocks. Paleozoic fossils were presence of the Geratites trinodosus formably overlying Favret contains ranges. The latest movement, during identified by J. S. Williams and L. G. zone of Middle Triassic age and pro- near its base such distinctive lower- the earthquake of 1915, caused dis-Henbest. Ward Smith was associated vides means for correlation of the most Middle Triassic genera of placement amounting to several feet

THRUSTING facies, thus furnishing means for the rocks, but the eastward overturn in

of the northern border of the quad- general paucity of organic remains formation are dolomites and lime- period of folding can be certainly rangle, and Lovelock is 25 miles to may indicate a brackish-water envi- stones of the Augusta Mountain for- distinguished, particularly in the ronment or at least a condition not mation. At the type locality of Tobin Range, north of Golconda conducive to abundant marine life. Augusta Mountain, three members Canyon. Here the folds in the On the other hand sporadic lenses of are recognized: the lower, massive Havallah and Pumpernickel forma-The Mesozoic and in part the Paleq- limestone containing brachiopods, dolomite and limestone; the middle, tions trend north and northeast; local zoic sedimentary rocks of the quad- corals, and reefs of Trichites, a large thinly bedded dolomites and limestone overturn to the west was noted in the rangle belong to sequences originally pelecypod with prismatic shell struc- interbedded with shales; and the up- southern part on the east flank of the deposited far apart and later ture, indicate that normal marine per, massive limestone and dolomite. range and to the east near the northtelescoped by movement on a large conditions existed intermittently in Except for a few pebbly dolomitic ern border of the quadrangle. Two low-angle thrust fault, the Tobin the basin in which the Grass Valley beds, the sediments of the Augusta faults, both probably small, thrust thrust, probably the same as the sediments were deposited. Mountain formation apparently are the Pumpernickel above the Havallah on the crest of the range. A fault quadrangle (fig. 1). The older Pale- more common near the top of the The fauna from the Augusta with a west to northwest dip, also ozoic rocks in both plates of this Grass Valley formation and herald Mountain formation consists domithrust were largely folded and broken the change which brought about the nantly of pelecypods, gastropods, along the west flank of the range

Winnemucca sediments in the Upper from the underlying cliff-forming UNCONFORMITY AT BASE 20° was observed in a few places.

THRUSTING The major feature of the Jurassic overlain by the Triassic rocks of the The Tobin thrust probably extends

referred only to "Upper Paleozoic". nodules or thin beds of impure lime- were folded and thrust prior to the thrust contact, possibly displaced Both the Inskip and the Havallah stone. The presence of Lingula deposition of the lower Pennsylva- by a normal fault, concealed beneath TRIASSIC FORMATIONS OF MOUNT TOBIN QUADRANGLE

DUN GLEN FORMATION OSOBB FORMATION

NATCHEZ PASS FORMATION | Pelecypods (new species)

- ? - PAVRET FORMATION

GRASS VALLEY FORMATION "Gardita" sp.

formations elsewhere CANE SPRING FORMATION DIXIE VALLEY FORMATION FIG. 1 -SKETCH MAP SHOWING INFERRED EXTENT OF TOBIN AND GOLCONDA THRUSTS 0 5 10 15 Miles

its contact with the diorite, crystal- present ranges.

Augusta Mountain formations. If Augusta Mountain and the southern feet along the southern portion of this rite, and diorite. In the southern part so, this thrust is a segment of the end of the Tobin Range. Most of fault. these faults have a small throw and Southward from Golconda and metamorphosed rocks assigned to Neither the direction nor the mag- in part fade out into small flexures. Canyon is a fault within the range the Leach and Koipato formations. beneath the outcrop of the thrust and Augusta Mountain the faults trend the lava contact.

the other hand, the Koipato forma- has taken place within the present defined scarp and the fault cannot be ciable thickness outside this direct result of such movement. It borders the valley.

to east. Erosion prior to the deposi- movement.

A later thrust, with a westerly dip above 6,100 feet. The steepness of of 5°, crops out along the east flank this scarp may be to some extent due plate of this thrust.

Structurally the Permian Koipato

Upper-plate facies

Alectryonia montiscaprilis

AUGUSTA MOUNTAIN

Gastropods (new species)

Geratites trinodosus

Acrochordiceras hyatti

(unfossiliferous)

TOBIN FORMATION

Glaraia, cf. G. aurita

KOIPATO FORMATION

Hungarites (?) sp.

Myophoria sp.

Lingula sp.

-ANGULAR UNCONFORMITY-

"Cardita" sp.

quadrangle, indicate a Permian (?) resting on an eroded surface of the yet completely known. In the ad- overlap by a later thrust the trace of age (Wolfcamp and possibly Permian Koipato formation. This jacent Golconda and Winnemucca the fault is not exposed. It is also Leonard); fragments of crinoid conglomerate is overlain by impure quadrangles, rocks of Cambrian, Or- possible that the Havallah formation stems from the Inskip (Reed Canyon, dolomites and dark and thinly bedded dovician, and Mississippian(?) age in the hills west of Goldbanks may Winnemucca quadrangle) could be shales which contain a few calcareous below the Tobin and Golconda thrusts belong to the upper plate, with

NORMAL FAULTS

All the formations of the quadran- the time of the 1915 earthquake Goldbanks.

contemporaneous with the Tobin Ranch. thrust; others developed later than North of Siard Ranch the range beneath the old valley fill are being Bailey, E. H., and Phoenix, D. A., he granitic intrusives but earlier front is offset a mile to the east and the actively eroded. In Pleasant Valley, 1944, Quick silver deposits in than the Tertiary lavas; still later scarp is less steep, but the Tertiary renewed erosion has stripped off the Nevada: Nevada Univ. Bull., vol

faults displace the lavas and in part lava west of the range is downfaulted, \$300,000 worth of gold and silver was excess of 2,500 feet. The fault apactivity in the district has been spoline limestone is thrust over the Normal faults older than the Tertiparently dies out sharply to the south, radic. In 1947 the only activity was Triassic formations of the lower-plate ary lavas are most abundant and for it does not displace the lava con-exploration at the Gold Note mine(1). facies. The rocks of the upper plate closely spaced in the less competent tact northeast of Pearce Ranch. The rocks in the area are principally are too altered to be identified with lower formations in the Triassic se- During the 1915 earthquake there graniticintrusives, including alaskite,

nitude of the Tobin thrust is deter- These normal faults are possibly due with a westerly dip that flattens from The ore deposits occur in quartz veins minable from the evidence now to tension in the upper plate of the about 60° in the north to about 30° at that trend north and northwest and available. The Triassic formations Tobin thrust caused by movement on the south end. At least at the north dip west and southwest. Most of the of the lower-plate facies in the Tobin an uneven plane, or they are due to end, displacement of the older rocks veins are in the intrusive rocks, but Range have a northerly strike directly later warping of the thrust plane. On appears to be greater than that of in the southern part of the district several veins are in the metamorare not overturned, but to the north, about north. Close to the front of the Faults that developed after the exposed rocks near the intrusive where the strike swings to the west range these are cut by faults that trusion of rhyolite bound the west contact. The metallic minerals are at the contact of the Natchez Pass strike a few degrees east of north and front of Augusta Mountain, 3 miles galena, sphalerite, chalcopyrite, arand Grass Valley formations, there is displace the Tertiary rhyolite. With north of the southern border of the senopyrite, pyrite, tetrahedrite, and a sharp overturn to the north. Rela- one exception the earlier faults quadrangle. These faults, which pyrrhotite; the galena is argentifertive northerly or northeasterly move- have had no renewed movement form a closely spaced group trending ous, and native gold is present locally. ment of the upper plate is also during later faulting. between N. 10° E. and N. 30° E., In places, tourmaline needles are suggested in outcrops of the possibly Faults transverse to the trend of truncate the older northerly faults found in the ore. The veins range identical Golconda thrust in the Win- the range displace the Triassic for- within the range. The aggregate from thin seams to some more than nemucca quadrangle. On the other mations of the lower-plate facies in displacement, as indicated by outliers 3 feet in width but commonly are hand, thrusts older than the Tobin the Tobin Range but not the Tertiary of the Augusta Mountain formation less than 2 feet in average width. thrust, involving the Triassic formalavas. One of these faults, however, and Tertiary rhyolite at the edge of Goldbanks district.—Quartz veins tions of the lower plate in the Sonoma bounds a small intrusive mass. Therethe valley, is about 2,000 feet. As in the Goldbanks district (Dreyer, Range (Winnemucca quadrangle), fore the transverse faults may be far as can be determined, the dips are 1940; Vanderburg, 1936) have been clearly moved to the west, and the younger than those which form the steep, exceeding 60°. At the south explored forgold and silver ore bodies. Triassic formations on the east flank closely spaced system cutting Trias- end of the range the frontal scarp The veins follow shear zones in Terof the East Range a few miles north sic formations of the upper plate. dies out abruptly and the frontal fault tiary rhyolite and strike north and of this quadrangle also are overturned Farther north, faults with similar appears to swing into the interior of dip steeply west. Exploratory work trend displace Tertiary lavas, but the range with a northerly strike. on two veins ranging from 4 to 6 feet The areal extent of the thrust plate movement along them may have The fault here dips about 40° W. in width has shown erratically disand the presence of different facies begun at an earlier period.

A late fault with a throw of probof the Triassic formations on the Longitudinal normal faults have ably over 1,000 feet borders the east production is reported to have been upper and lower plates suggest move- determined the present outline of the flank of Augusta Mountain at its only about 120 tons of ore averaging ment of considerable magnitude. On ranges. To some extent this faulting southern end, but there is no clearly \$25 a ton in value.

tion, as far as known, is a local physiographic cycle, and the steep traced northward beyond the point QUICKSILVER DEPOSITS volcanic formation, present in appre- frontal scarps are at least in part the where the gently tilted rhyolite The quicksilver deposits are in rocks of Paleozoic, Mesozoic, and quadrangle only in the East range is likely, however, that many of the The fault scarps which originated Tertiary age. The deposits in Paleo-Winnemucca quadrangle) and in the frontal scarps are the result of down- at the time of the 1915 earthquake zoic and Mesozoic rocks are replace-West Humboldt and Stillwater faulting and subsequent erosion of extend across the quadrangle. For ment deposits in limestone and shale Ranges, a few miles to the the west the less resistant Tertiary lavas and the most part they follow closely the and have been productive in the and south. The presence of the tuffs along the present range fronts faults which border the front of the Mount Tobin mine, and at the Old-Koipato formation in both plates of and that the frontal scarps are pre- Tobin Range, usually in the gravel timer property south of Goldbanks. the thrust is therefore an argument vailingly fault-line scarps or fault- or at the contact of rock and gravel, The deposits in Tertiary rocks are in against major movement from west line scarps accentuated by later but in places the scarps displace the opalized and chalcedonized pyrorock close to the range front. At the clastic rocks (opalite). The most tion of the Triassic formations has The northern part of the Stillwater north end of the Tobin Range the productive property has been the completely removed the Koipato Range is a horst, on both flanks of scarp is not continuous and its maxi- Goldbanks mine.

formation in the lower plate in the which are downfaulted Tertiary rocks. mum height does not exceed 3 or 4 Goldbanks district. - The Gold-Tobin Range; there is likewise a On the east the range is bordered by feet, but bordering the range front banks mine (2), (Bailey and Phoenix, thinning out of the Koipato in the a graben developed after the basalt south of Siard Ranch a continuous 1944; Dreyer, 1940) is in the low hills upper plate in China Mountain (Gol-flows of the Sou Hills. On the west scarp reaches a maximum height of on the west side of Pleasant Valley. conda quadrangle) about 20 miles to flank the bounding fault appears to 16 feet at Pearce Ranch. Southward The mine has been worked at interthe north-northeast. The areal ex- die out to the south, but according to the scarp decreases in height but vals since 1913 and is credited with a tent of the Havallah formation, also Louderback (1904, p. 324 and pl. 21), borders the Tobin Range to a point total production of 1,563 flasks by the present in both plates, is unknown. the west front at the extreme south- southeast of Miller Ranch. The next end of 1943. The ore bodies are in Two thrusts in the East Range are era border of the quadrangle is bor- scarps noted are to the west in the opalite, which was formed by the presumed to belong to the same oro- dered by a fault, and the basalt on Sou Hills, where west-facing echelon silicification of ash and tuff beds and geny. The thrust on the west flank the crest is horizontal but is broken scarps have a maximum height of 3 intercalated sediments. The ore of the East Range carries the Penn- by faults with downthrow on the or 4 feet. Finally, small scarps of mineral is cinnabar, which was desylvanian (?) Leach formation over west. On the east front, however, the same degree of freshness, pre-posited in two zones 2 to 7 feet thick, Triassic(?) crystalline limestone and the frontal scarp becomes more sumably formed at the same time, parallel to the bedding. The ore dolomite. It is possible that this is a clearly defined to the south. At a were noted near the crest of the mined in places contained severa the latest Paleozoic formations of consisting of dolomites and lime- loids. The fossils are for the most Ranch. This fault cuts the northern segment of the same thrust which point 3 miles north of the southern Stillwater Range. These also face percent of quicksilver but probably encloses the fenster at Willow Creek a border, the topographic map shows west, opposite the displacement on averaged less than 1 percent. few miles to the north (Winnemucca an average slope of 34° from 4,000 to the major fault bounding the east The Oldtimer mine (3), about 7 6,500 feet in altitude and about 21° flank of the range.

was exploited during 1941 and 1942. GEOMORPHOLOGY The production is not known. The of East Range and carries the Inskip to the greater resistance of the masand Pumpernickel formations above sive diorite which here forms the that occurred during Pleistocene time fault zones cutting limestone and the Havallah and Koipato formations, range front, but other formations affected the present relief of the quartzite of Triassic age. here overlain by the Tobin formation also are truncated by the scarp. Furmountain ranges occupying the The Pronto Plata property (4) is 4 of the upper-plate facies. The outlier thermore, the small steep fans and greater part of the Mount Tobin miles northwest of the Goldbanks of the Triassic Prida and Natchez the lower base level of Dixie Valley, quadrangle is uncertain; it is also mine. The property has produced a Pass formations of the lower-plate which has caused the stripping of the uncertain to what extent such fault- small amount of quicksilver from facies on the range front south of valley fill in Pleasant and Jersey Valing may have caused actual uplift of opalite; the cinnabar is in erratically Peavine Creek is interpreted as a leys, suggest that the height of the the ranges. Some surface features distributed pockets, and the ore downfaulted segment of the upper scarp may be due in part to recent appear to be best explained by inter- discovered thus far is of low grade. downfaulting in Dixie Valley. mittent uplift over a much larger Mount Tobin mine.—The Mount The Triassic formations of the The west border of the East Range area, with local downfaulting of some Tobin mine (5) is in the central part upper-plate facies of the Tobin thrust, southeastward to Frenchboys Canyon valleys, such as Dixie Valley, creating of the Tobin Range near the head of although tilted and faulted, are not follows a nearly straight course, new base levels and causing subse- Golconda Canyon. The property was folded. The Triassic formations of transverse to the internal structure; quent erosion of those valleys less operated from 1941 to 1943 and by the the lower-plate facies, on the other this fact, together with the presence directly affected by recent faulting. end of 1943 had yielded 1,491 flasks hand, are sharply folded in places of hot springs and the general east- The preservation of remnants of of quicksilver from ore ranging in but lack the intense folding which ward tilt of the basalt on the east old surfaces at accordant levels suggrade from 7 to 12.4 pounds to the characterizes this facies in the Sono- flank, may be indicative of a border- gests that here, as in the Winnemucca ton. The ore mineral is cinnabar, ma Range and the northern part of ing fault, but there is no clearly quadrangle, the major outlines of the which replaced argillite, limestone, the East Range (Winnemucca quad- marked scarp. There is no evidence present ranges were developed by and conglomerate of Permian (?) rangle). The westward overturn of that the eastern border of the range depression of the valleys, following age; rhyolite of Tertiary age nearby the Paleozoic in the East range at was determined by recent faulting. and concomitant with widespread also contained small pockets of cinthe northern border of the quadrangle The Tobin Range is bordered on epeirogenic uplift. Minor tilting is nabar. Properties in the vicinity, is the southern end of a larger struc- both sides by well-marked fault not excluded, but the major tilt of including the Last Chance mine and ture which in the Winnemucca quad- scarps. The scarp on the east flank the fault blocks must have preceded the North Fork property, are credrangle involves Triassic rocks. It is (Mount Moses quadrangle) is the the formation of these surfaces. The ited with small productions, but the therefore regarded as the result of steeper and straighter and is also concordant levels indicating periods grade of the ore is low. Jurassic folding, superposed on the marked by recent gravel scarps, but of relative quiet are developed at NICKEL AND COBALT

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earlier Paleozoic folding. at the southern end, within the Mount about the same elevations as in the Evidence from this area indicates Tobin quadrangle, the continuation of Winnemucca quadrangle, although Nickel and cobalt deposits (Ferguonly that this younger orogeny oc- the range-front fault is overlapped by the old upland topography at about son, 1939) have been found in Cottoncurred later than Upper Triassic time Tertiary lavas, suggesting that the 8,000 feet in altitude is well preserved wood Canyon on the east flank of and earlier than the intrusion of the major movement was older and that only on Augusta Mountain. The Stillwater Range, from a few hungranites. Muller (Muller and Fer- the scarp is largely a fault-line scarp intermediate terrace, which is roughly dred feet to a half mile south of the guson, 1939, p. 1615), however, has with some revival of movement at between 6,000 and 6,500 feet in altishown that in the West Humboldt the north end. tude and present on all the ranges, is morphic rocks probably belonging to Range, a few miles to the west, Lower On the west flank faulting was shown principally by accordance of the Pumpernickel and Havallah for-Jurassic sedimentary rocks are con- more complex. Some of the faults ridge elevations and a few gravel- mations. The deposits consist of formable on the Upper Triassic rocks. on which recent movement has taken covered benches such as that on the veins generally less than 4 inches Areal distribution of granitic intru- place were initiated before the outflow crest of East Range at the head of wide, some filled with nickel minerals sives to the west strongly suggests of the Tertiary lavas. Especially at Frenchboys Canyon. The level at about and others with nickel, cobalt, and that the intrusive masses of the East the south end, faulting was accom- 5,000 to 5,500 feet is also widespread; copper minerals. Originally the filling and Stillwater Ranges are satellitic panied by progressive eastward tilt- in the gravel flats in the upper part of the nickel-bearing veins probably to the Sierra batholith. It is there- ing of the range, shown by the fact of Leach Canyon, the gravel-covered consisted of gersdorffite (sulfarsenide fore reasonable to infer that this orothat the dip of the rhyolite is steeper benches near McKinney pass, the flat of nickel) and tetrahedrite. There geny took place during the Jurassic than that of the overlying andesite. crests of the Sou Hills, the pass at has been little production. The major frontal scarp extends from the head of Golconda Canyon, the Siard Ranch southward to Miller benches along the front of Augusta 'Numbers in parentheses refer to locations on Wash. The principal movement at Mountain, and the hills west of map.

gle, including the unconsolidated (Jones, 1915; Page, 1935) took place There have been relatively recent valley fill, are cut by normal faults. along this fault: the maximum dis- revivals of erosion in Pleasant and Certain faults may be approximately placement of 16 feet was near Pearce Jersey Valleys. At the head of Jersey Valley, Tertiary sediments valley fill as far north as Miller 38, no. 5, Geol. and min. ser. 41, Ranch; the south-flowing Spring pp. 170-176. Creek has cut a deep narrow gorge Dreyer, R. M., 1940, Goldbanks min through Triassic dolomite at the ing district, Pershing County, Nev.: southern end of this valley. It is Nevada Univ. Bull., vol. 34, no. 1, assumed that this is the result of Geol. and min. ser. 3. lowering of the base level in Dixie Ferguson, H. G., 1939, Nickel deposits

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Goldbanks and Mount Tobin districts, mining districts in Humboldt

DEPARTMENT OF THE INTERIOR GEOLOGY Includes fans and desert wash bordering the mountains; also playa deposits and lake beach deposits (Pleistocene) of Buena Vista and Dixie valleys UNITED STATES GEOLOGICAL SURVEY MOUNT TOBIN QUADRANGLE W. E. WRATHER, DIRECTOR Calcareous sinter deposited by hot springs Older gravels Gravel laid down during older crosion cycles, mapped in part only Scoriaceous and rapy to massive Andesite and andesite agglomerate
On east flank of Tohin Range SMALL ANGULAR UNCONFORMIT nd deeply weathered. Small erosion rem-nants below rhyolite MAJOR EROSIONAL UNCONFORMIT LOWER PLATE OF TOBIN THRUST UPPER PLATE OF TOBIN THRUST UPPER AND LOWER PLATES GRADATIONAL CONTACT STILLWATER RANGE SECTION ALONG LINE A-A' * NEW FORMATION SECTION ALONG LINE B-B' l where believed accurate to scale of map. Dashed where sketched in part or adjusted to topo aphy; probably essentially accurate. Dotted where sketched, inferred, or concealed; may b Geology mapped in 1939-41 Base map enlarged and modified and in 1945 and 1947 from southwest quarter of aw-teeth indicate upper plate. Faults dashed where sketched in part or adjusted to topographs probably essentially accurate. Dotted where sketched, inferred, or concealed; may be inaccurate Sonoma Range, Nevada, quadrangle GEOLOGIC MAP Topography by R. C. Seitz and W. G. Carson by Ellen B. Bennett OF THE Generalized strike and dip of gently dipping beds MOUNT TOBIN QUADRANGLE, NEVADA Generalized strike and dip of steeply dipping beds By S. W. Muller, H. G. Ferguson, and Ralph J. Roberts Scale 1:125,000 Generalized strike and dip of gently dipping overturned beds ½ 0 1 2 8 4 5 Miles APPROXIMATE MEAN DECLINATION, 1951 Contour interval 100 feet Generalized strike and dip of steeply dipping overturned beds Datum is mean sea level 1951 Strike of vertical beds Horizontal beds ∞ 2 Mine

EXPLANATION