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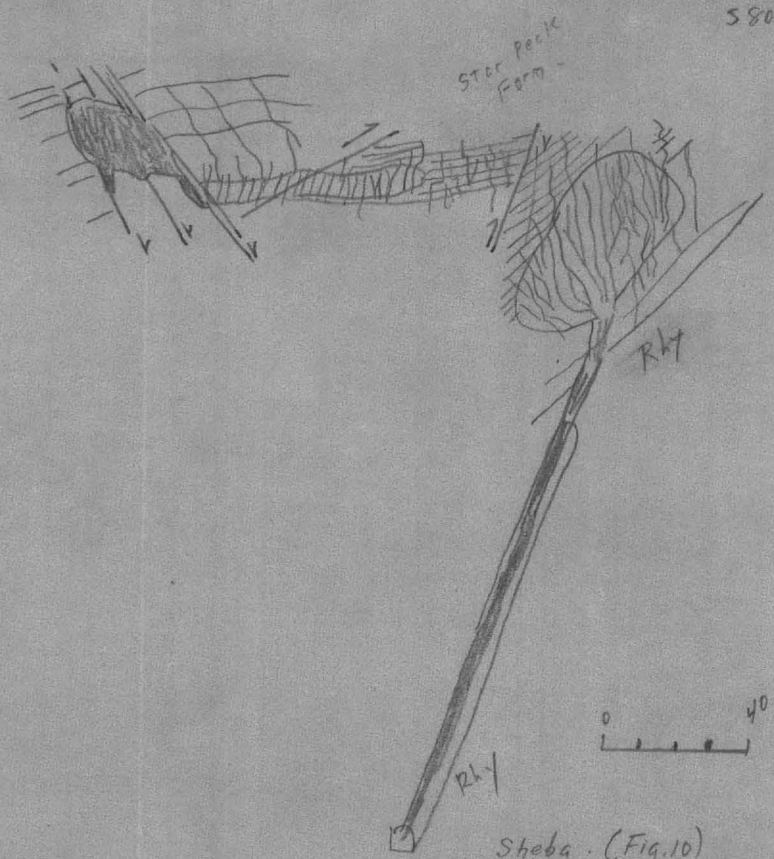
Tehama
Tehama Canyon
Sta. Clara
Champion
Sheba
DeSoto
Pflum
DeSoto
Star Basin
Bloody Canyon
Bloody Canyon
Larnon Canyon
QAl
Jura-Cret Gp
Trias Star Peak formal
Basal clastics
COYOTE CANYON
QAl late Pel or Trias
Rhy. form
Keratophyre
GEOLOGY OF THE NORTHEASTERN HUMBOLDT RANGE
0 250 5000
Lead
Marigold
Black Warrior Mine
Arizona
Wheeler
Graben
Plate 2



Sheba. (Fig. 10)

ANTITHETIC FAULTS

GEOLOGY AND MINERALIZATION OF THE NORTHEASTERN HUMBOLDT RANGE, NEVADA. E.N.Cameron: Bul.GSA 50 (1939), 563-634.

History.- Silver deposits discovered in Star Canyon, 1861. Three main silver mines: Sheba and De Soto in Star Canyon; Arizona south of Unionville. Total production of area $5,000,000 in silver; $75,000 to $100,000 in antimony and perhaps $50,000 in gold.

Location.- Star Peak range, NE slope of N division of Humboldt Range, Pershing Co. About 5 miles S of Mill City.

Columnar Section: Geologic History. Oldest rocks, possibly late Paleozoic, are keratopheric tuffs and flows, at least 1500', overlain with apparent conformity by IB rhyolite tuffs and flows 900±1800'. Entire series overlain with apparent conformity by middle and upper Triassic ls. and clastics.

These rocks folded and faulted along axes along NNE axes, slightly oblique to the trend of the present range, and have been intruded by olivine diabase to GP. Ores of Ag, Au and Sb related to these intrusives. This orogeny and its intrusion and mineraliz generally referred to late Jurassic or early Cretaceous.

Peneplanation followed, but this erosional cycle was interrupted, probably in the Pliocene, by uplift of the present Star Peak range as a long, narrow, eastward-tilted range, chiefly along normal faults marking W margin of range. Uplift in two principal stages separated by an interval during which the range was maturely dissected. Olivine basalt flows found with trachyte por. and trachytic ash along base of range in present area were extruded toward close of interval of dissection.

Column.-

Age	Mode of Occurrence- Stratigraphic Divisions.	Descriptions
Quaternary	Alluvium, bench gravels	Gravels, conglomerates, fanglomerates.
Pliocene?	Flows and intrusives	Olivine basalt, trachyte por., trachytic ash, olim db.
Jura-Cret?	Intrusives	Metagabbro por., meta-ol.db, metasyenite, GP.
Jurassic		Argillaceous slates
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Late Paleo or Triassic	Rhy formation	900-1800	IB rhy flows & tuffs.
	Keratophyre form.	1500' plus	IB K flows & tuffs. Base not exposed. Marked flow-banding.

Keratophyre formation: original comp. probably andesite to olivine basalt. These rocks schistose in places :the tuffs especially; but local shearing of the lavas has produced rocks consisting of unreduced augen of lava in fine schistose sericiti and chloritic material, striking resemblance to sheared coarse tuffs. Concluded that the albitization and accompanying alteration of the Keratophyric rocks and the Jura-Cret.? basic rocks (see below) is the result of Jura-Cret? shearing and HT alt.

Rhyolite Formation.- Ag,Au, Sb deposits in upper part. Light-colored, gray or purple blocky felsites. Much banded or streaky flow structure; some of flows have a slabby or thinly platy ~~flxxxstructurexparakle~~ parting parallel to flow structure.

Like keratophyres,rhy volcanics have been sheared & HT alt., chiefly by sericitization and silicification.

Star Peak Formation.- Main mineral deposits. Like the underlying volcanics, Star Peak ls. sheared during Jura- Cret? orogeny

Jura-Cret? Intrusives.- Meta-olivine db.,metagabbro por, metasyenite, chiefly as sills. Granite por,better called rhy por-principal intrusive,as dike-like or irreg.masses elongated roughly parallel to axes of post-Jurassic folding. Conspicuous phenos of flds or qtz or both in an aphantic or visbly spherultic GM. Phenocrysts of qtz and alkali flds. are embayed,in a granophyric GM of qtz and orthoclase. Flds phenos include perthitic soda orthoclase and soda microcline,and normal albite-twinned albite. "Later introduction of albite,probably during mineralization,is shown by quartz-albite veinlets in some specimens ".

Tertiary Igneous Rocks.- Olivine basalts, probably Pliocene;ol. db dikes, small, in or near fault zones.

Structure.-

1. Jura-Cret orogeny: Jurassic and older rocks folded along axes N25E,oblique to range trend;in area mapped fault zones roughly parallel to the axes of folding were initiated. There followed peneplanation, then

2. Uplift,probably beginning in Pliocene. Star Peak range uplifted as long,narrow, E-tilted block,chiefly by displacements along normal faults marking its W margin. Two stages of uplift (Knopf and Jenney, bibliography),in the interval between which the range was maturely dissected,and basalt flows and associated igneous rocks emplaced.

3. Structure of Present Area. S of area principal structural feature of range is a broad, S-plunging anticline broken by faults. In present area,continuation of this anticline plunges N25E from S margin of area nearly to Coyote Canyon. N of Coyote Canyon axis n not clearly traceable, but apparent plunge is S.N of Larned Creek

only the W limb is exposed in the range. From Bloody Canyon N dips on this limb get steeper until at Tehama Caonyon beds are oveturned, dipping 80E. Between Unionville Canyon and Star Basin major fault zones parallel to and W of the main area parallel folds with which they are associated. The major folds are corrugated by many minor flexures.

Faults. Most apparent displacements are parallel to dips. Near faults the rocks have been shattered, dragged and sheared. Gouge common; in places extensive crush zones nearmajor faults. Beds adjacent to faults strike parallel to them, due to drag and rotation.

Faults of 3 ages (1) accompanying post-Jurassic folding; premineral. (2) intramineral faults; (3) post-mineral faults. Major fault zones seem to have originated in the Jura-Cret. orogeny. Antithetic Hts. of Sec A In the N part, especially, this seems so: reverse or steep normal faults, major fault zones associated with folds, parallel, and both oblique to the trend of the range; the magnitude of the folds; all suggest origin during Jura-Cret. folding.

The major fault zones seem pre-mineral; but in considerable part the displacements along the fault zones are post-mineral, and probably represent dying phases of Jura-Cret. orogeny. Some PM faulting clearly later, probably connected with late Tertiary block faulting. S of Arizona mine (Plate 2) late Pliocene ol.db. dike cut off by narrow NW fault zone.

Mineral Deposits.

Silver from quartz bed veins, fissure veins, stockworks. Stibnite-quartz veins. Minor gold-quartz veins.

Silver veins and stockworks in lower part of Star Peak and in rhyolite. Primary freibergite, Ag-galena and jamesonite, and pyrargyrite, in varying %; supergene argentite and native Ag.

Sb veins in rhy and silty ls., mainly in Jackson and Bloody Canyons. Here stibnite in pods, streaks, lenses in qtz. veins ~~als~~ along narrow steep sheeted zones in rhy. Ore bodies only in upper most flows of rhy.

The hypogene ore deposits have several common features: except for differences in wall rocks, WR alteration similar: silic sericit, pyrit. "The distribution, the forms, and the internal structures of the deposits indicate a close relationship between mineralization and deformation which took place prior to and during mineralization." Further, the early stages of mineraliz. essentially similar. Concluded the deposits formed during single epoch of mineralization and under same conditions of moderate T and P. Solutions related to the Jura-Cret. intrusives.

Silver Deposits.

Main ones Arizona and Sheba-De Soto. 3 forms: bed veins, fissure veins, stockworks. Bed veins in silty ls. worked in most of the Arizona group, in American Basin mine and Pflum; these have yielded most of the silver. 1" to 7' thick; essentially conformable to enclosing beds. All in lower part of Star Peak, within lower 400'. This part of the section is characterized by gray to blue-black, thin-bedded, relatively pure, finely crystalline limestones, IB with brown, gray, pink, purplish shaly, silty and sandy layers, some of which are dolomitic. Principal impurities chert and detrital quartz, muscovite and alkali felds. Between 100 and 150' above base is prominent facies, 100' thick, composed of gray med-cse grained dolomitic, limontic quartzites and quartz ss with rough slabby parting at an angle to the bedding.

Fissure vein and stockwork deps. in lower part of Star Peak and i rhy. Shba mine.

Bed-veins. Most of district silver from the area around the Arizona mine. Belt of ls. and associated strata bounded chiefly by normal faults, along which it is dropped down with respect to the adjacent rocks. In area of Plate 2 Star Peak nowhere more than a few hundred feet thick; in places erosion has exposed the underlying volcanics. Beds dip generally E, but attitudes vary widely owing to minor folds. Many faults; most normal faults trending N10E to N50W, dipping 25W to 60E.

Bed veins at about same horizon in silty, laminated or shaly ls, about 40-50' above top of basal clastics. (Basal clastics tuffaceous ss and congl merates). This correspondence in position does not necessarily mean deposits represent a single originally continuous bed vein, since bed veins found at several horizons in Arizona mine within a vert. distance of about 25', Further, pre-mineral faulting evidence makes it doubtful that beds were continuous at time of mineraliz. Seems more probable that correspondence in position due to formation of favorable channels only in certain silty ls. beds which yielded during deformation by separation along closely spaced lamination surfaces.

In Arizona workings beds dip E, strike N5-40W. Beds and vein are displaced a few inches to 15' by normal flts. N20-50W, dipping 25-50W. "A few apparent reverse faults are probably rotational". (p.597) Where faults closely spaced narrow zones of relatively large displacement occur. These zones trend N20-40W, dip 30-40W. Owing to divergence of fault-zone and ls trends, N part of deposit is divided into parallel troughs plunging gently SSW. (Fig.6).

Near faults the ls. and vein material have been crushed and flexed and the vein in places has been pinched out. Fault surfaces marked by seams of black carbonaceous gouge containing fragments of brecciated vein material. Thick gouges along Stewart and McDougal flt. zones.

Main bed vein few inches to 7', ave. 2.5'; seems to have followed essentially a single horizon thruout the mine. Vein contacts frozen except near flts. Vein walls, usually sharp and parallel, clearly indicate separation of the silty ls. along lamination surfaces. Ransome (1909, p.40) says: "There is no evidence of any important replacement, and the quartz has crystallized in open spaces produced by

the separation of the limestone al ng one or more bedding planes. The banded structure (of the vein) suggests that the separation was effected by successive movements, each followed by the 'deposition of quartz". Cavities and comb structure evidence open spaces during early quartz deposition. Thin sections of the vein show successive movements during min.which sheeted early quartz parallel to the vein surfaces and opened channels for the entrance of later vein minerals. Open spaces could hardly exist over any sizeable area with gently dipping beds and under the 6000' of beds inferable during the mineralization. But successive shearing movements parallel to bed planes might provide open spaces ~~xxxxx~~ at a structurally favorable horizon first at one point and then another,resulting in formatipn of a vein over a considerable area.

Replacement important in Arizona bed vein. Replacement of inclusions and partings in bed vein by quartz an important cause of the banding in the ore. See marginal relations just w of Stewart flt. zone, Fig. 1 - local replacement.

According to Raymond (1872,p.135) ore along the Stewart fault zone for 400 ' S of the intersection with the Fall tun. Where seen at the N end of the mine the "ledge " is a definite vein 1-12 " thick along a fault fissure within the Stewart fault zone. Similar fissure vein stoped at intervals for 400 ' along MacDougal fault zone can be traced along line of Fig.8 downward and westward into the main bed vein. The fissure vein seems to be a spur of the main bed vein along a fissure within the MacDougal fault zone;but the relation of this vein to the bed vein E of the fault zone could not be determined. It seems probable that the Manitowoc vein is the upfaulted extension (eastern) of the Arizona vein,of which the fissure vein along the Stewart fault zone is a spur. No indications were seen that the fissure veins continue into depth.

Put in T.A.

Main displacements on MacDougal and Stewart fault zones are PM. But formation of veins along fissures parallel to the PM flt surfaces would seem to indicate that deformation along these zones b began prior to mineraliz. Deformation during min.indicated by distribution of sulphides in the fissure veins in streaks and bands formed by replacement of quartz along sheet fractures parallel to the walls. Iniation of faulting in the area of Plate 2 prior to miner. is indicated by the Gov. Bradley vein along a fault. (H).

<u>Fissure Veins and Stockworks.</u> Sheba mine. Main ore bodies in lower 100 ' of IB ls. and tuffaceous basal clastics , between dark shaly carbonaceous ls. and rhyolite (markedly porphyritic-phenos of quartz and alkali flds.,like granite porph.) Beds strike N-S, dip E. E part of deposit connected with a fissure vein 1-3 ' in underlying rhy,striking N12E, dip 75 W. Vein contacts s.t. frozen;elsewhere they are smooth, gouge-coated walls. Full width s.t. ore;at other places elongate inclusions,large or small mark branches in the controlling sheet structure, Vein stoped for 250 ' along strike. At contact between rhy.and overlying tuffaceous ss.vein changes abruptly to wide stockwork,mainly veinlets along fracture cleavages dipping steep E. Whole mass stoped over 150 ' along strik Drive from top of this chamber connects with W workings. Strata here traversed by many veinlets along steeply dipping fracture cleavage;these are very closely spaced in this ls. beds. Stoped,see section. W of here,at (4) is a stope 150 ' long,30 ' high,20 ' wide,trends N10E parallel beds ;confined to massive tufface.ss bed

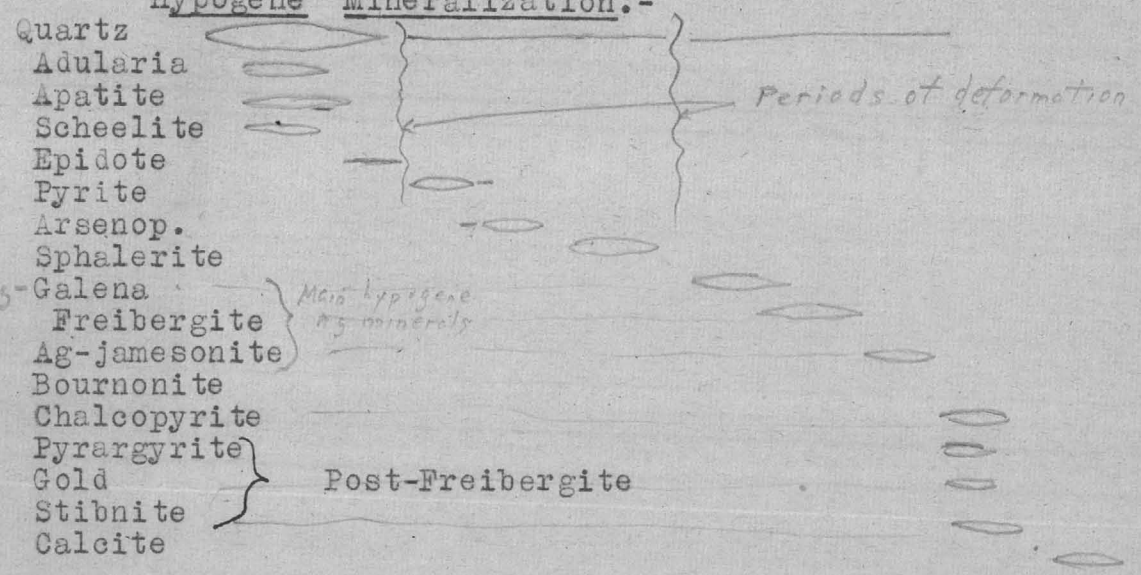
At intersection of the ss with series of E-dipping PM normal faults; OB result of partial replacement of adjacent fractured rock by VM entering along the fault fissures.

Bed- Vein Ore. Mainly gray to milky qtz., variable but prevailingly coarse texture. Some drusy cavities and comb structure. Banding parallel to walls usually conspicuous. Due to (1) thin carbonaceous seams and silty ls. partings; (2) streaks of dark fg. qtz representing silic. partings whose original angular outlines are indicated by the distribution of unreplaced particles of carbon and other impurities; (3) ribboning due to shearing parallel to the vein surfaces (4) dissemination of metallic minerals in one or more layers parallel to the vein surfaces.

In much of the ore the metallic minerals form minute particles disseminated thru bands of med-fine gr. qtz.; soft shadowy gray. Py only visible in some specimens; in others tetrahedrite, galena, ZnS etc. seen. In places irregularly distributed streaks and bunches of coarser sulphides found. Ore high in silver shows greenish-black sooty blebs, argentite, covellite, chalcocite, native Ag and cerussite.

Fissure Vein and Stockwork ores. Mainly coarse milky qtz., massive or with ~~coarse~~ rude comb structure; scattered drusy cavities. Local ribbon structure. Metallic minerals sparsely distributed in streaks and bunches; s.t. dissem. in bands. Met. mins. usually coarser in texture than those of bed veins. Fissure veins have many wall rock inclusions, many of which show partial replacement.

Hypogene Mineralization.-



The hypogene mineralization was accomplished in successive stages, delimited by periods of fracturing. During each stage deposition took place by metasomatic replacement of earlier minerals along shear zones (???) and fractures. Qtz. deposited during all s stages.

Supergene Minerals, Arizona Mine. (1) argentite later than Freibergite; formed mainly by replacement of Freibergite, in small part by replacement of sphalerite and galena. (2) Argentite associated with, and frwquently IG with, covellite, and in places Cu_2S. In large part covellite and chalcocite are later than argentite. (3) In rich ore, sooty greenish-black spots or masses partly fill cavities left by removal of known hypogene sulphides, and ore of this type reported to assay up to 1750 oz. Ag and 0.5 oz. Au. These masses are mixtures of argentite, covellite, chalcocite and oxidation products replacing freibergite aand associated sulphides along intricate networks of irregular fractures. (I think residual ar argentite.) (4) Relation to fractures in quartz which, unlike fractures produced during hypogene mineralization, have not been healed by later quartz and which therefore appear to be post-hypogene.

Native silver as small particles (evidently plates) assoc. with limonite, cerussite, malachite, azurite and copper sulphates; in consierable part is disseminated in cerrusite. In part a direct oxidation product of silver-bearing sulphides; in part clearly introduced, and has resulted in enrichment of the ore in silver.

Supergene Enrichment of Silver Deposits.- 2 reasons for thinking commercial ore bodies due to supergene enrichment of lean protore (1) Clear evidence of enrichment by supergene argentite and native silver; (2) rich ores found near the surface. Arizona mine: development proceeded S from N end of deposit, following plunge of structural troughs. Grade of ore mined:

1869..... $100/ton
1875..... 30
1908 21

(This seems downright silly. Sndary enrichment may work for a steep vein; and probably does for copper. But the Arizona bed vein must plunge S at an extremely gentle angle. The N portals are on the side of a rather steep canyon flowing NW; portals at 6500' elev. S portals at 6360', which should just about take care of the plunge. Bed vein must have outcropped in gulch at N portals. Why should supergene solutions have carried silver flatly into the hill along the tight bed vein ?) Admits Sheba- De Soto probably not supergene enriched. This is along steep cfacks and fissures and is the very one that should be. Freibergite was bulk of ore, 1866-1875,

Argentite formed by replacement of freibergite. Pyrite & arsenop. not replaced.

Max. expl. depth 300' "Supergene" sulphs. found at vein O.C's. Enrichment unrelated to present water level. Some "supergene" sulphs. found above the water table.

Sb Deposits

Bloody Canyon & Black Warrior mines; P. Flum

Bloody Canyon - Zone of steep sheet-fissure vein. N 30W to N 25E. Main OB's in upper part only. Stope - ore confined to 1'-3'. Zone - N-S, 80W. Bounded by smooth, gouge-coated sheet surfaces. Zone mainly - simple qtz fissure vein, but grades thru rhy. frag. to stockwork. Use bladed stibnite, some rz 6 with qtz, as steels, brittles, flutic masses. Stib. mostly filled fractures in qtz or replaced fractured qtz; S.T. forms veinlets in inclusions or filled fractures in the walls.

Productive shoots alternate with barren portions.

The competent intrusive andesite at Tuscarora played the same role as the competent rhyolite at Antelope, forming the host rock for the veins. Only strong rock can fissure under uplift; the soft bedded rocks at Tuscarora fractured intensely but irregularly; doubtless it "flowed" as well.

While at Antelope antithetic faulting seems to have taken place after the metallization, at Tuscarora if Nolan is correct, antithetic faulting occurred before metallization, although some movement occurred along some vein-fractures after their veins were formed. It is probable that at Tuscarora both the antithetic faults and the zones of sheeting in the intrusive andesite originated as tension fissures along the east flank of the Tuscarora arch; that with continued uplift certain tension fissures were selected to serve as rotational faults and that after they had locked themselves and could rotate no further uplift that still persisted pulled open stronger members of the sheeting system to permit entry of silver-bearing solutions. Similar post-faulting uplift at Bodie formed the "enrichers" of the Burgess series which crossed and enriched veins along the antithetic faults, movement on which had by that time ceased.

Star Peak Range, Nevada

Source.-

E.N.Cameron(1939), Geology and mineralization of the northwestern Humboldt Range, Nevada, Geol.Soc.Am.Bull.vol.50, p.563-634.

General Introduction

Examples of elongated arches with longitudinal tension fissures, antithetic faults and crestal graben offered so far involve mainly middle or late Tertiary deformations of Tertiary extrusive bedded rocks (Creede, Jarbridge, Calico, Parral, Bodie, Antelope, Tuscarora).

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Where pre-Tertiary rocks are involved in the deformation, the examples so far have come from the plateau area of Mexico and south Texas, where "compressional" folding is largely lacking (Terlingua, Las Damas, Santa Eulalia). That arching in the districts so far described resulted from vertical forces will be admitted by many.

If however the mechanics of arching developed are sound, vertical forces must be postulated where the fracture pattern developed on an anticline in a region where direction of deforming forces is debateable is identical with fracture patterns on arches whose origin by vertical forces admits of little doubt. The Star Peak district, Nevada, is a case in point.

The Star Peak Range forms the northeastern portion of the Humboldt range and lies a few miles north of Rochester, in northwestern Nevada (Plate 1). The present range was uplifted in the Pliocene as a basin range tilted eastward and bounded on the west by west-dipping normal faults; but the deformation to be described dates from the post-Jurassic Nevadan orogeny.

The oldest exposed rocks, probably late Paleozoic, in age, consist of 1500 feet or more of keratophyric tuffs overlain by 900 to 1800 feet of rhyolite tuffs and flows. Overlying the Paleozoic(?) series with probably unconformity is the Upper Triassic Star Peak formation consisting of thick and thin bedded limestone with intercalated sandstone and shale; at the base is a clastic horizon of sandstone, shale and conglomerate. The Star Peak formation, 3500 feet thick, carries the principal ore deposits. Jurassic argillaceous slates lie unconformably above the Star Peak sediments.

Intrusive rocks, presumably latest Jurassic or early Cretaceous in age, include dike-like or irregular masses of rhyolite porphyry and "granite porphyry"), and sills of diabase, metagabbro porphyry and metasyenite.

Structure.- During the Jura-Cretaceous orogeny the Jurassic and older strata were folded along N25°E axes, oblique to the trend of the Pliocene range. The major fold is an anticline, plunging south in the area south of the Star Peak district, north in the southern part of that district and south again in the northern part. Minor parallel folds are superimposed upon the major fold; axial planes of these minor folds are overturned down the west and east flanks of the major arch (Figs.34A,34B).

Since rock exposures coincide with the present north-south range and the Nevadan folding trends north-northeast, oblique to the range, the west flank of the major anticline is exposed in the northern part of the district (Fig.34A) while in the southern part the crest is visible (Fig.34B).

The western flank of the arch in the northern area exhibits a series north-northeast faults, paralleling the axis. Most such faults dip toward the axial plane and have their downthrow in that direction; some faults are nearly vertical (Fig.34A).

On the crest of the arch, in the southern area, normal faults parallel in strike to the anticlinal axis dip toward it from the west and east flanks, fan-fashion. This conjugate system of faults has produced a composite graben (Fig34B).

Several of these major faults are associated with folds of the superimposed group which trend roughly parallel to the faults (Cameron, 1939, p.591). The faults formed in pre-mineral time, but a considerable part of their displacements are post-mineral. Intramineral faulting took place also.

Ore Deposits.- The Star Peak district has produced about $5,000,000 worth of silver, together with relatively unimportant amounts of gold and antimony. The deposits, fissure veins, stockworks and bedded veins, are for the most part adjacent to or within the major fault zones. Thus the Sheba-De Soto and other deposits in the northern area lie within the northeast belt of

step-faults on the west flank of the major anticline (Fig.34A). Most of the ore bodies were in mineralized fault zones close to and parallel with the major faults;but of a few deposits lay along the major faults themselves.

One group of deposits,including the principal silver mine of the district,the Arizona, lies wholly within the composite graben on the crest of the arch in the southern area (Fig.34B).

Throughout the district ore-forming solutions utilized the major fault zones as trunk channels.

Mineralogically the deposits fall into three types:silver, gold and antimony.Hydrothermal alteration has affected the wall rocks adjacent to the deposits,but there is no relation between type of ore and type of alteration,the latter depending entirely on the kind of rock altered. Sericitization and silicification characterizes altered feldspathic rocks such as the late Paleozoic rhyolite flows,the tuffaceous Star Peak basal clastics and the rhyolite porphyry intrusives.

Silicification of these wall rocks hugs the veins while sericitization extends farther away from them.

Calcareous rocks of the Star Peak series are far less altered;although they carry veinlets of quartz, adularia and apatite,such veinlets are confined closely to the borders of the ore channels.

The chief silver deposits were those of the Sheba-De Soto mine,in the zone of step-faults of the northern area,and those of the Arizona mine, within the graben of the southern area.

The Sheba-De Soto ore bodies were found in the lower 100 feet of the Star Peak formation,where limestone grades downward by interbedding with clastics into the wholly clastic basal series. The beds dip west,down the western flank of the major anticline,and are broken by innumerable fractures of the east-dipping set,parallel to the step-faults of the area.

The eastern portion of the main ore body was connected with a narrow, west-dipping fissure vein in the rhyolite underlying the Star Peak formation. The vein carried ore in the rhyolite,but where the fissure left rhyolite to enter the tuffaceous sandstone of the overlying basal clastics,the simple fissure was replaced by a wide stockwork which also made ore but consisted of closely-spaced sheeting planes dipping steeply east.

The eastern part of the ore body was linked with the western by a series of ore veinlets in Star Peak sediments.The western portion of the ore body was a replacement of tuffaceous sandstone beds with their intersections with east-dipping minor step-faults of the step-fault system.

The bulk of silver production from the Star Peak district came from one or more bedded veins in the Arizona mine within the Arizona graben (Fig.32B). The main vein followed a single stratigraphic horizon in silty,shaly laminated limestone about 50 feet above the Star Peak basal clastics.

The mine lies toward the eastern border of the graben,where the latter is broken by closely-spaced minor step-faults that parallel the eastern boundary faults of the composite graben. The minor faults shown in the section,although they fault the ore bed,probably existed as tension fissures at the time of ore formation;or if not,faulting on them at that time was less than today,because the major part of the faulting is post-mineral.

The ore bed averages 2 ½ feet in thickness. Vein contacts were frozen except near post-mineral faults. Quartz of the deposit was grey to milky,with prevailingly coarse texture;drusy cavities and comb structure occurred in places.Banding parallel to the walls was conspicuous;according to Cameron,the banding was mainly caused by differential replacement

of limestone layers between unreplaced shaly partings. Ransome, on the other hand, who saw the vein during active mining on it, believed much of the banding was due to recurrent pulling apart of limestone layers from their shaly partings, each opening being filled instantly by vein matter.

In the ore of the Arizona bedded vein metallic minerals formed minute particles disseminated through bands of quartz. Pyrite only was visible in some places, but in others tetrahedrite, galena, and sphalerite appeared. Rich ore showed blebs of argentite, chalcocite, covellite and native silver.

In fissure veins and stockworks of the northern area the quartz was coarse, milky, massive-textured or with rude comb structure. Locally it exhibited drusy cavities with ribbon structure. Metallic minerals, sparsely distributed in streaks and bunches, were coarser-textured than those of the bedded veins. Many wall rock inclusions, some partly replaced, were enclosed in the fissure veins.

According to Cameron hypogene mineralization took place in successive stages delimited by periods of inyramineral fracturing. During each stage deposition in the bedded veins took place by replacement of earlier vein m minerals. Quartz deposited during all stages.

Tectonic Analysis of Star Peak District.- Cameron shows a close time relationship between deformation and mineralization:

"The distribution, the forms, and the internal structures of the deposits indicate a close relationship between mineralization and deformation which took place prior to and during the mineralization." (1939, p.594).

That the major fault zones furnished trunk channels for mineralizing solutions is also recognized by Cameron:

"A close relationship exists between the distribution of the deposits and the occurrence of, and structural features of, major fault zones in the area, This relationship is believed to indicate that the channels of mineralization were produced by the same deformation which produced the fault zones, and that the fault zones, therefore, were initiated prior to mineralization." (1939, p.627).

Small-scale faulting of ore bodies,such as that of the Arizona bedded vein,took place after metallization. Although one or two ore deposits lay along major step-faults,it seems logical to suppose that during the time the present major step-faults and graben faults furnished channels for metallizing solutions they were still tension fissures formed by upfolding of the major anticline,and that post-minera mineral faulting on minor fractures reflects major fault movements at the same time on the larger fractures. As shown in Figure 34A, the step-faults along the western flank of the arch are antithetic faults that have been strongly rotated. Such fractures would offer much more permeable channels of mineralizing solutions at an earlier stage,when they were steeply-dipping tension fissures.

The Star Peak major upfold has a relatively simple form,resembling the arches formed in layered extrusives of Tertiary age at Creede,Jarbri bridge, Antelope, Tuscarora,Bodie and elsewhere. The heterogeneous, generally thin-bedded Star Peak formation by itself,might be supposed,un under uplift,to deform more complexly. Underlying this series,how-ever,is 2000 feet of highly competent rhyolite,strong enough to lift its thick cover and largely protect the latter from flowage, complex folding etc.

Ransome has been quoted to the effect that the banded structure of the Arizona bedded vein originated through pulling apart of lime-stone layers from shaly partings. Tectonic considerations suggest that this is possible. In dropping of the Arizona graben block the massive rhyolite below the Star Peak thin-bedded sediments would tend to descend as a solid keystone block bounded by sharp faults of planar shape. Laminated beds above the rhyolite would tend to gape along their laminae in trying to keep pace with the relatively

rapid drop of the solid block beneath them. This might explain opeming of layers in the Arizona ore bed during mineralization.

Cameron observes that early quartz and adularia deposited at about the same time in all the Star Peak ore deposits,and that differences in subsequent mineralization might be explained by differences in the times at which renewed deformation produced new channels by fracturing the earlier vein matter. Progressive changes in composition of solutions would in that case produce variations in the metallic content of ore in varoous deposits,because,while change in composition of solutions might have been smoothly progressive,time of opening of fracture fractures to receive them varied from deposit to deposit,depending as they did on complex conditions of local structure and strain.

Blue Wing Tungsten District, Idaho

Sources.-

Eugene Callahan and Dwight M.Lemmon(1941), Tungsten resources of the Blue Wing District,Lemhi Co.,Idaho,U.S.Geol.Survey Bull.931A.

Alfred L.Anderson(1948),Tungsten mineralization at the Ima mine, Blue Wing District, Lemhi Co.,Idaho,Econ.Geol.vol.43,p.181-206.

Another district,the deformation and metallization of which considerably antedates those associated with the later Tertiary districts which have formed the bulk of examples ~~offered so far is~~ the Blue Wing tungsten district in east-central Idaho(Plate 1),~~of which~~ the Ima mine is the principal producer.

Granite has invaded Beltian micaceous quartzites ~~intercalated~~ with

Sheba Ore Bodies pointing (?) where ↓

STAR PEAK

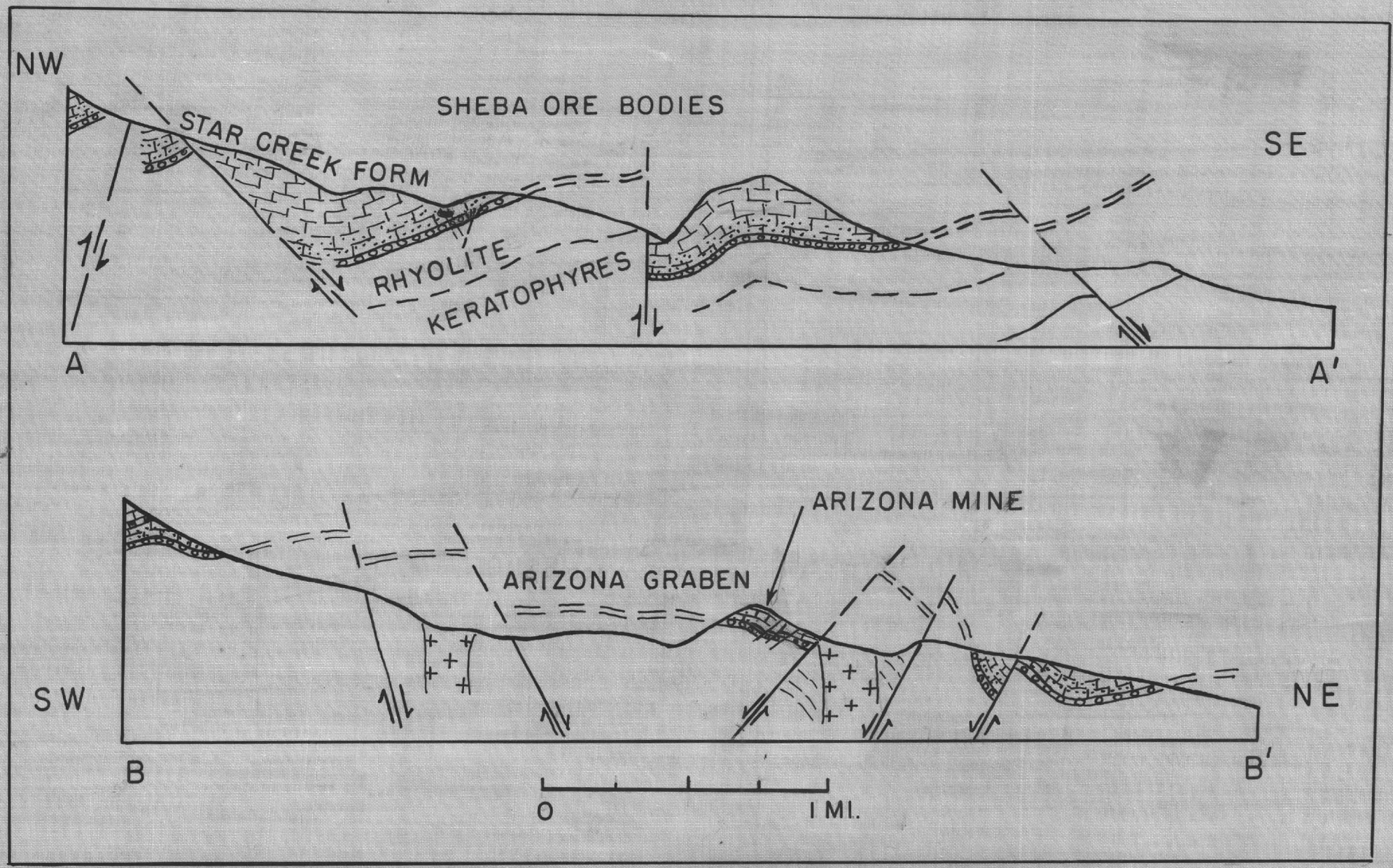

FIG. 34

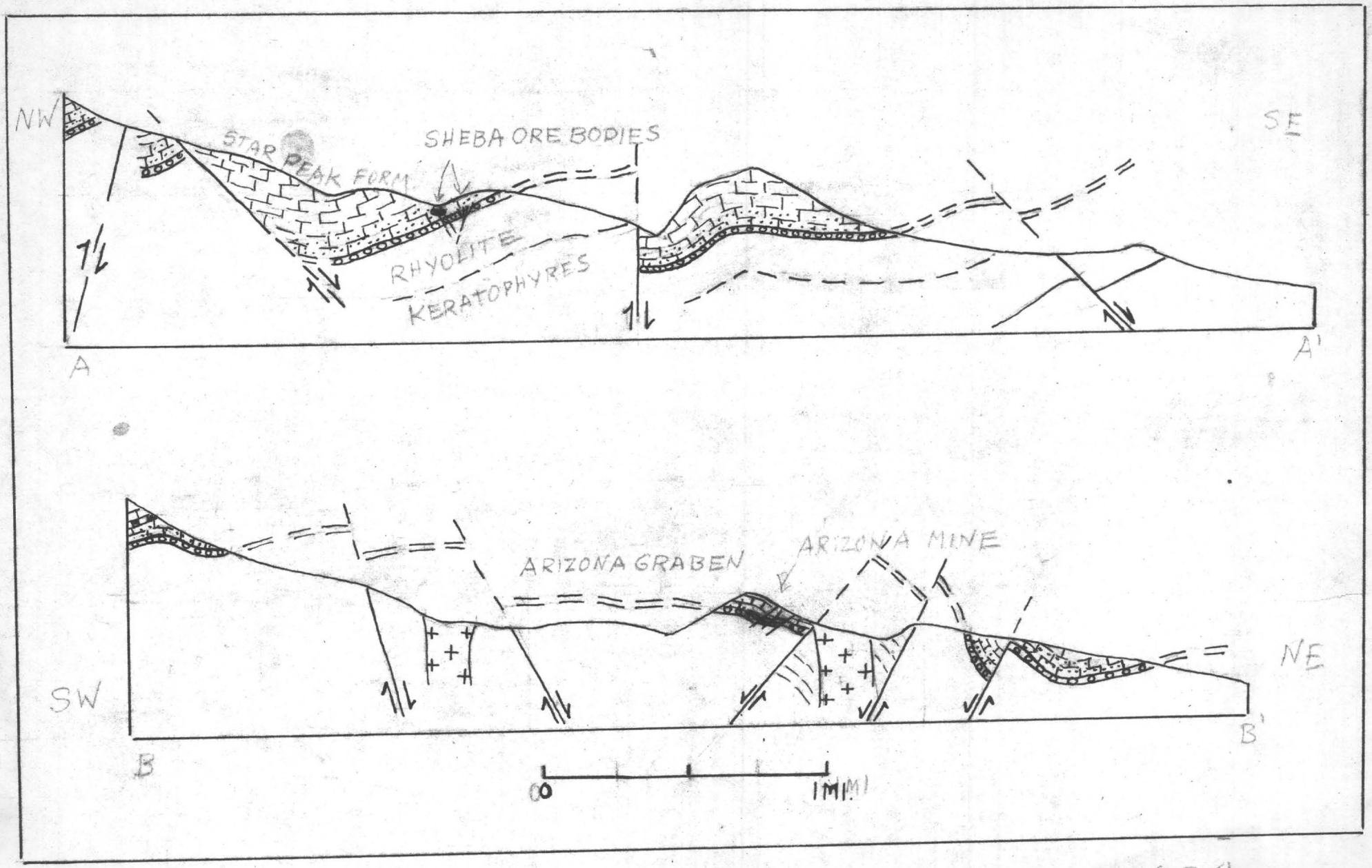
NW
SE
STAR PEAK FORM
SHEBA ORE BODIES
RHYOLITE
KERATOPHYRES
A
A'
ARIZONA GRABEN
ARIZONA MINE
SW
NE
B
B'
0
1 MI

FIG 34

GSA Bull. vol. 71, 1960, p. ~~2070~~ 2082

XLI B-2

STRUCTURAL FEATURES OF THE HUMBOLDT RANGE, NEVADA

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The structure of the Humboldt Range in northwestern Nevada is an elongate anticlinorium of Permian and Triassic rocks that is overridden by thrust plates and nappes made up of rocks of Triassic and Jurassic age; these are cut by a system of normal faults, some of which form range boundaries.

The anticlinorium, composed of a set of canoe-shaped anticlines, trends slightly east of north across the more northerly trend of the range itself. Segments of the normal faults bounding the range diverge widely from the northerly trend, and at least one segment cuts diagonally across the range. Pliocene and Pleistocene fanglomerates derived from an ancestral Humboldt Range have been broken by normal faults and progressively tilted. Block faulting has continued into the Recent.

A synclinelike structure in the southern part of the range is interpreted as a segment of a large recumbent anticline overturned from southwest to northeast. The overturned block is further cut by a net of closely spaced normal faults. In the northern part of the range there are blocks that override from northwest to southeast and others that override from east to west. Both the north-trending folds in the main part of the range and the thrusts and nappes were developed after Early Jurassic time and probably before early Tertiary time.