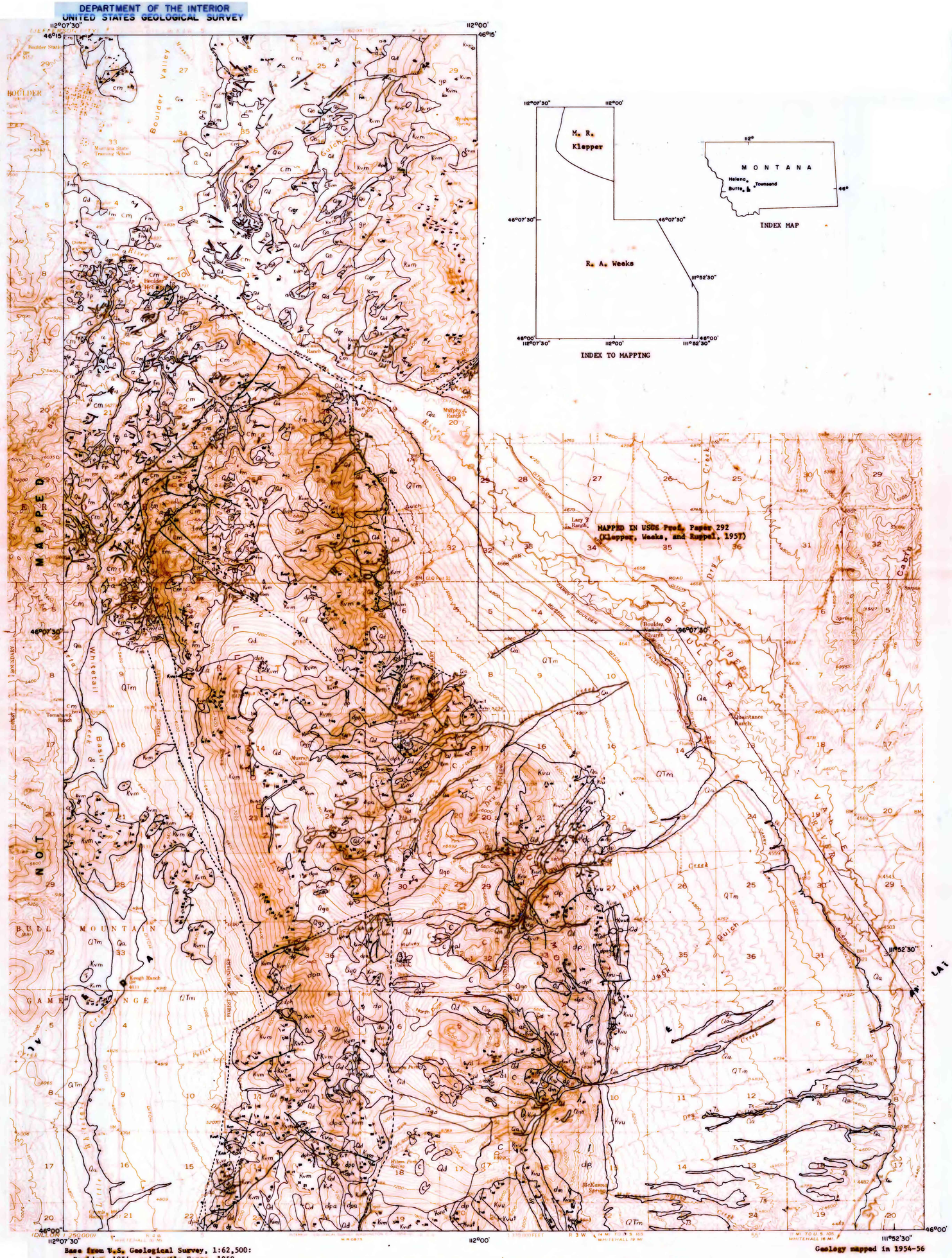

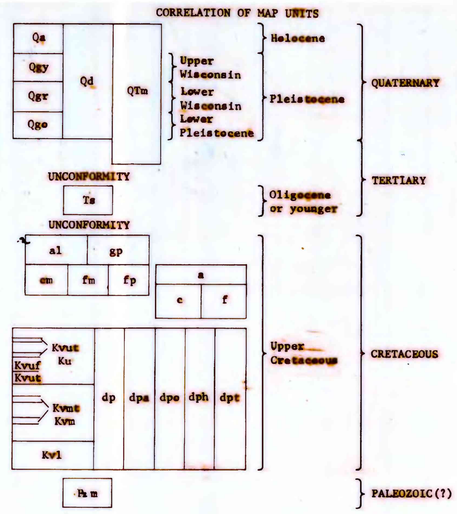

DESCRIPTION OF MAP UNITS

Qa ALLUVIUM (HOLOCENE)--Deposits along modern streams

Qd DEBRIS DEPOSITS (HOLOCENE AND PLEISTOCENE)--Broad areas on the hillsides and upland basins on Bull Mountain mantled by stony soils and unconsolidated deposits of bouldery debris, resulting from slope wash, mud flows, creep, and related mass-wasting processes

GLACIAL DEPOSITS

Qgy Younger glacial deposits (upper Pleistocene--upper Wisconsin)--Small deposits with characteristic morainal topography near the summit of Bull Mountain. Deposits contain unsorted bouldery material of local drainage area

Qgr Gravel deposits (upper Pleistocene--lower Wisconsin)--North of the Boulder River lower hills are capped by relatively thin unsorted deposits of pebbles, cobbles, and small boulders in a matrix of silt, sand, and gravel. The coarser material is composed of resistant rock types found in the drainage area. Deposits probably represent morainal material of local glacial lobes

Qge Older glacial deposits (lower Pleistocene)--Unconsolidated coarse debris covers several ridge tops north of Wilson Park and part of the spurs of Bull Mountain. Deposits typically are a few tens of feet (20+ m) thick but locally may be as much as several hundred feet (100 m) thick. Deposits are characterized by unsorted angular to rounded pebbles, cobbles, boulders, and angular blocks of many lithologies in a matrix of clay, silt, sand and gravel. Coarse material averages about 4-8 inches (10-20 cm) in diameter, but individual blocks as much as 32 feet (10 m) across and many boulders 5-10 feet (1 1/2-3 m) in diameter are present. Larger debris is dominantly composed of resistant rock types and locally as much as 20 percent of these are of lithologies not found in the Bull Mountain area. Included in the exotic material are quartzites from the Quadrant Formation, cherts probably from the Phosphoria Formation, salt-and-pepper sandstones from the Kootenai Formation, Paleozoic limestones, and Mesozoic sandstones. Coarseness and heterogeneity of this material indicate the deposit must be a remnant of a glacial moraine. A source area containing all the lithologies lies north of the Boulder River in the southern Elkhorn Mountains, about 18 miles (28 km) north of the southernmost limit of this material

QTm MANTLE DEPOSITS (QUATERNARY AND UPPER TERTIARY)--Unconsolidated generally poorly sorted silts, sands, gravels, and coarse debris that mantle broad areas in Boulder River and Little Whitetail Creek valleys. Include leg gravels weathered from Tertiary strata, stream-channel deposits, coalesced fan deposits, and redistributed talus. Ranges in thickness from a few feet (1 m) in the southeastern part of the area to several tens of feet (20-30 m) near the mountain fronts. Lag gravels locally may be as old as mid-Tertiary. Stream deposits are of locally derived origin, and were deposited during the cutting of a pediment surface that bevels Tertiary strata. Fan gravels are dominantly of late Pleistocene age and include glacial outwash. Talus accumulations at the foot of the steep scarp along the western flank of Bull Mountain have been redistributed by slope wash, mud flows, and stream action, and are of Holocene and late Pleistocene age

Ts SEDIMENTARY ROCKS (OLIGOCENE OR YOUNGER)--Light-colored (shades of yellow, pale orange, and light gray) tuffaceous siltstones, sandstones, and conglomerates, weakly to moderately consolidated, easily gullied and eroded to form bare rounded hills with little or no soil. Volcanic glass is a conspicuous component of most beds. The siltstones contain angular to subrounded detrital grains of quartz, feldspar, rock fragments, volcanic glass, and lesser amounts of biotite, hornblende, and magnetite in an argillaceous matrix; sparse calcareous cement in some beds. The sandstones and conglomerates are poorly sorted; some beds show crossbedding and channeling. They contain rock fragments derived largely from Elkhorn Mountains Volcanics and associated intrusives, with subordinate quartzite. The conglomerates contain subangular to rounded pebbles and cobbles as much as 5 inches (12 cm) across but averaging 1-2 inches (2.5-5 cm). Total stratigraphic thickness exposed <350 feet (100 m)

ROCKS OF THE BOULDER BATHOLITH (TERTIARY OR CRETACEOUS)

Late stage

al Alaskite, aplite, and related rocks--Includes small pegmatite dikes, aplite dikes, and numerous small stocks of alaskite and leucoquartz monzonite and associated dikes

gp Granite porphyry--Medium-light-gray fine-grained granite containing rounded quartz phenocrysts 2-4 mm long and some feldspar phenocrysts as long as 6 mm. Feldspar is in part relict plagioclase replaced by K-feldspar, quartz, and sericite, in part micro-pegmatitic intergrowths of K-feldspar and quartz, and in part orthoclase. Groundmass is anhedral quartz, K-feldspar, and micropegmatitic intergrowths of the two. Biotite is the principal mafic mineral

Main stage

cm Coarse- to medium-grained quartz monzonite--Medium-gray; contains hypautomorphic granular aggregates of plagioclase, K-feldspar, and quartz, with subordinate biotite or biotite and hornblende. Accessory amounts of sphene, apatite, magnetite, and rare zircon are present. Textures range from nearly equigranular through seriate to porphyritic. Most rocks contain a few conspicuously larger phenocrysts of K-feldspar. Grain size ranges from about 0.5 mm to several centimetres, but typically is a few millimetres

fm Medium- to fine-grained quartz monzonite--Average grain size of about 0.2-0.3 mm; sparse subhedral plagioclase phenocrysts as long as 3 mm and aggregates of mafic minerals, dominantly biotite, a few mm across. Otherwise, the mineralogy is similar to the main mass of the batholith (unit cm). Several small areas and a larger area near the eastern contact of the batholith south of Boulder River

fp Fine-grained porphyritic quartz monzonite--Small bodies characterized by large (3 cm) subhedral phenocrysts of K-feldspar, most of which poikilitically enclose plagioclase, biotite and some quartz. Locally may also contain smaller phenocrysts of subhedral to rounded plagioclase, anhedral quartz, and biotite in a fine-grained (average about 0.2 mm) groundmass of intergrown K-feldspar and quartz and subordinate plagioclase and biotite

ROCKS OF THE WILSON PARK STOCK (TERTIARY OR CRETACEOUS)

a Aplite dikes and related rocks--Locally a few dikes of aplitic texture and granitic to syenitic composition cut the stock. Other dikes contain slightly coarser porphyritic rocks of alaskitic composition

c Coarse-grained quartz monzonite--Main mass of the stock consists of coarse-grained (5-10 mm average) quartz monzonite. K-feldspar is more abundant than plagioclase, and quartz is subordinate in amount. K-feldspar occurs in large subhedral to anhedral crystals poikilitically enclosing plagioclase and mafic minerals, and as anhedral interstitial grains intergrown with quartz. Plagioclase mainly forms euhedral to subhedral crystals. Quartz is in anhedral interstitial grains and in intergrowths. Mafic minerals typically form aggregates, and may include hypersthene, augite, hornblende, biotite, and magnetite. Hypersthene when present is intergrown with augite. Augite typically is rimmed and irregularly replaced by hornblende or biotite, and the hornblende also may in part be replaced by biotite

f Fine-grained quartz monzonite to granite porphyry--Near the eastern and northern contacts of the stock the rocks are dominantly fine-grained porphyries containing K-feldspar phenocrysts as long as 1 cm, subhedral to corroded plagioclase phenocrysts a few mm long, and aggregates of mafic minerals in a fine-grained (0.1-0.3 mm) groundmass of K-feldspar, plagioclase, and quartz

ELKHORN MOUNTAINS VOLCANICS (UPPER CRETACEOUS)

Kvu Upper member--A sequence of dominantly water-laid andesitic tuffs and volcaniclastic sedimentary rocks ranging from conglomerates to mudstones with a few lenticular beds of fresh-water limestone and some andesitic flows. Thickness as much as 7,800 feet (2,100 m)

Kvut Andesitic tuffs

Kvuf Andesitic flows

Kvm Middle member--A sequence of quartz latite ash-flow tuffs, most of which are partly to strongly welded, and some interlayered well-bedded ash-fall crystal tuffs and subordinate thin-bedded water-laid tuffs. Proportion of ash-fall tuffs decreases northward, so that north of the Boulder River the member is almost entirely a succession of welded tuffs. Thickness >4,500 feet (1,300 m)

Kvmt Well-bedded ash-fall crystal tuff

Kvl Lower member--Massive conglomerates, breccias, and lapilli tuffs. Thickness probably several hundred feet (200 m)

dp INTRUSIVE EQUIVALENTS OF THE ELKHORN MOUNTAINS VOLCANICS (UPPER CRETACEOUS)--Dominantly fine-grained porphyries of dioritic to syenodioritic composition, with subordinate amounts of subporphyritic to seriate textured rocks. Several varieties have been separated according to dominant phenocrysts:

dpa Augite

dpo Augite and relict olivine

dph Hornblende

dpt Altered tourmalinized porphyry

Pzm METAMORPHOSED SEDIMENTARY ROCKS (PALEOZOIC?)--A sequence of medium-bedded interlayered light-gray fine-grained calc-silicate rocks and subordinate dark-greenish-gray biotite hornfels with a few thin medium coarsely crystalline marble beds, underlain by a sequence of massive light-gray to yellowish-orange medium to coarsely crystalline dolomitic marble cut by a fretwork of fine-grained silica stringers and limonite. The upper sequence probably represents the lower 100 feet (30 m) of the Amsden Formation; the massive dolomitic marble probably represents the uppermost 150-300 feet (45-90 m) of Mission Canyon Formation

CONTACT

FAULT--Dashed where concealed. Bar and ball on downthrown side

STRIKE AND DIP OF BEDS

Horizontal

Inclined

Vertical

Overturned

STRIKE AND DIP OF JOINTS

Inclined

Vertical

Intersecting sets

STRIKE AND DIP OF FOLIATION

VEIN

PROSPECT

GEOLOGIC MAP OF THE BULL MOUNTAIN AREA, JEFFERSON COUNTY, MONTANA

By

Robert A. Weeks

1974

REFERENCE

Klepper, M. R., Weeks, R. A., and Ruppel, E. T., 1957, Geology of the southern Elkhorn Mountains, Jefferson and Broadwater Counties, Montana: U.S. Geol. Survey Prof. Paper 292, 82 p.