UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Field Trip Guide For
The West Tintic Mining District, Western Utah

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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The West Tintic mining district is located in western Utah near the eastern margin of the Basin and Range Province. The district is on the Cherry Creek 7.5 minute quadrangle, located in the northeast corner of the Delta 1^{o} X 2^{o} quadrangle, and lies in a region of rolling topography south of the Sheeprock Mountains and west of the West Tintic Mountains (fig. 1) (all illustrations are at end of report). The famous Main and East Tintic mining districts, which contain carbonate-hosted Pb-Zn-Cu-Ag-Au replacement and fissure-filling Au-Ag deposits, are located about 40 km to the northeast (fig. 1). The West Tintic district shares some several characteristics with the very productive Main and East Tintic districts, such as the presence of steeply folded and locally brecciated Paleozoic carbonate host rocks, numerous Oligocene stocks and plutons, and similarly-oriented, strong northeasterly structural trends. The West Tintic district was initially mapped by Morris and Kopf (1970) at 1:24,000 scale (fig. 2). Detailed mapping of surface and underground exposures at 1:12000 scale during the summers of 1987 and 1988 revealed a far more complex sequence of Oligocene and possibly Miocene igneous rocks associated with multiple mineralizing events than was previously recognized (Figure 3). The only existing radiometric data bearing on the ages of intrusions in the West Tintic district is a 38.8 corrected K-Ar age for "older plutons in the southern Sheeprock Mountains" (Morris, 1987). The West Tintic intrusions themselves have not been dated.

The West Tintic mining district contains four distinct types of ore deposits which appear to have had highly different histories of formation. Each of these four types is directly or indirectly related to a Tertiary intrusive event, separate in time, though partially overlapping in space. As a result, earlier formed deposits and related intrusions have been overprinted by later alteration associated with subsequent ore-forming events, making paragenetic interpretation on the district scale extremely complex. The four types of deposits in the West Tintic district are (1) W, Cu, and Fe-Cu skarn associated with the large West Tintic quartz monzonite pluton, (2) Cu-Mo porphyry associated with a newly discovered, highly silicic-felsic, fine-grained granite, (3) base +/- precious metal replacement in Ordovician carbonates, probably related to small aplite dikes associated with granite porphyry, and (4) disseminated Au associated with Tertiary monzonite sills and Precambrian phyllites at the base of the slivered Precambrian Sheeprock thrust sheet exposed in the northeast part of the district.

The field trip consists of six stops accessed by roads that are in poor to very poor condition. Drive slowly and carefully. Most of the following field stop description is based on work completed in summer 1987 by Holly Stein, David Kelley, and Jon Kaminsky. Ian Gordon, a volunteer with the U.S. Geological Survey, mapped during summer 1988 in Scotia Gulch and other areas east of the main West Tintic quartz monzonite pluton. Four of the six stops have been informally named "The Bates Trend", "The Wall", "The Southwest Toe", and "Little Bingham"; the other two stops are at the Iron King mine and the Scotia and Walker mines (fig. 3).

At present (1988), Cornucopia Resources Limited and Centurion Mines Corporation are in joint venture exploring for near surface, oxidized, precious metal deposits. Gold, silver, and base metal production began in the district in 1871 and continued until 1920. The tungsten mines were developed in the early 1940's (Desert Tungsten Mining Company) and drilling for porphyry

Cu-Mo commenced in the 1950's (Newmont Mining Company, New Jersey Zinc Company, and Cerro De Pasco Corporation among others). There has been essentially no exploration in the district using modern methods. Present interest in the West Tintic district is strictly for precious metals. Old assays from the Scotia mine indicate that some ore grades topped several ounces/ton Au. Assays of 149 samples taken from the Scotia mine before its shut-down in 1920 averaged 0.27 ounces/ton Au and 8.0 ounces/ton Ag (The Mining Record and Pay Dirt, April 1988). The widespread distribution of about 30 gold-producing mines combined with the near surface location of high-grade ore make the West Tintic district a favorable target for a large, open-pit mining operation.

STOP 1: THE BATES TREND: TUNGSTEN AND COPPER SKARN DEPOSITS

The Bates trend consists of a north-south series of shafts aligned along the intrusive contact of the West Tintic quartz monzonite (Tqm) to the north, and along the granite porphyry (Tgp) to the south (fig. 3). The Tqm is a typical, coarse grained, plutonic-looking version of quartz monzonite to monzonite and the granite porphyry is a phenocryst-rich unit, with diagnostic bipyramidal to rounded quartz eyes that give the granite its informal field name of "BB" granite. The skarn is primarily developed in a tongue of Ordovician Pogonip limestone which extends in an island-like manner into the intrusive margin or along the igneous/limestone contact (figs. 4 and 5). Skarn character and mineralization type is correlative with adjacent intrusive rock type. The **shafts to the north** (Tintic Western, Sullivan, Bates, and others) sport classic tungsten skarn mineral assemblages -- host rocks are white and consist of clean limestones that have been recrystallized and converted to wollastonite + calcite +/- tremolite + local opal and rhodochrosite. Distinct bands of apple green grossularite garnet are ubiquitous, replacing favorable beds in heterogeneous limestone lithologies. These grossularite bands are well exposed in outcrop on the upper Bates trend road, as regional bedding is near vertical. Tungsten occurs as scheelite in erratic disseminations in the white skarn and in 30 to 50 cm wide limonite veins (Lemmon, 1969). The absence of dolomite in the Pogonip Group has a positive affect on tungsten grade, as calcium activity is important in the precipitation of scheelite. **The shafts to the south** (Murphy and others) expose a copper tactite skarn, consisting of thin, anastomosing to massive veins of oxidized copper and iron minerals. The related skarn assemblage is generally an intense red-brown color largely the result of abundant and massive andradite garnet and local siderite. Some chalcopyrite and bornite may be visible, but most of the mine dump material consists of secondary oxidation products. Malachite is present as stains to local botryoids; epidote, chlorite, calcite, magnetite, specular hematite, and tremolite-actinolite are obvious, quartz and pyrite are present, and galena and possibly molybdenite are rare. The presence of epidote + quartz and the abundance of garnet are more commonly associated with copper skarns than tungsten skarns, and indicate relatively oxidizing conditions.

A base metal halo extends eastward from the shafts at the southern end of the Bates trend; this base metal halo is not present eastward from the northern shafts, again indicating that the Bates trend skarn is related to two different intrusion types.

Rhyolite porphyry and aplite dikes, generally less than a few meters wide, are present in the Bates trend area; they are slightly porphyritic, have a sugary groundmass, and are commonly sericitized and bleached in appearance. These dikes are presumably related to granite intrusions at depth and are not directly related to the formation of copper and tungsten skarn deposits. They may, however, be associated with the development of small, peripheral base metal occurrences in the southern part of the Bates trend.

There are no modern studies of the tungsten and copper skarn deposits in the West Tintic mining district. The district cannot claim large total tonnages of tungsten, but between May 1942 and June 1944 the Desert Tungsten Mining Company produced 7198 tons of fairly high grade ore (average grade = 1% WO_3) containing 6734 units of WO_3 (Hobbs, 1945; Wilson, 1950). One unit of WO_3 = 1% WO_3 = 20 pounds WO_3.

Nearly all mineralization of economic interest is present in the exoskarn environment or in veins along the contact between carbonate and intrusive; there is no well-developed endoskarn mineralization at West Tintic. Pyroxene and/or hornblende hornfels(?) are locally developed in the northern part of the Bates trend along the contact with the West Tintic quartz monzonite (Tqm), but are not associated with the granite porphyry (Tgp). These hornfels(?) may actually represent the formation of a small amount of endoskarn, created where fluid flow was locally confined to the Tqm pluton, adding calcium, destroying potassium feldspar, and leaving behind the diagnostic plagioclase + pyroxene (+/- amphibole +/- biotite) metasomatic assemblage. Development of endoskarn is far more typical in tungsten skarn than copper skarn.

STOP 2: THE IRON KING MINE: A Fe-Cu SKARN DEPOSIT

Just northwest of the northern end of the Bates trend, the Iron King mine represents yet another type of skarn deposit in the West Tintic mining district (fig. 3). The Iron King contains an Fe-Cu skarn deposit. The two Iron King shafts reflect somewhat different, but possibly related, material mined at depth. Though collared in carbonate, the **southwesternmost shaft** indicates the mining of a very mafic skarn assemblage, possibly all contained in the West Tintic quartz monzonite (Tqm) in extensively developed endoskarn. The abundance of massive magnetite, dark amphibole, chlorite, epidote, grandite garnet, and magnesite and siderite are characteristic of magnesian calc-silicate mineral assemblages associated with a variety of iron skarn found adjacent to small stocks of granodiorite to granite in the western Cordillera. This magnesian calc-silicate assemblage at the Iron King occurs as metasomatic pods and masses in Tqm. In some cases, where metasomatism has created secondary amphibole and possibly pyroxene, "fresh" Tqm has the appearance of a mafic diorite. An intense, dull green color in Tqm is the result of extensive propylitization. Massive epidote, chlorite, and carbonate attest to this pervasive propylitic alteration. Minor pyrite, chalcopyrite, and pyrrhotite, as well as sphene, talc, and serpentine are also present and reflect this magnesian calc-silicate environment. Magnetite may form readily in magnesium skarns, because magnesium calc-silicates do not take up much iron in solid solution at the oxidation states typical of skarn-forming environments. The **northeasternmost shaft**, also collared in carbonate, displays a massive meter wide vein of gossan which can be traced N25°W up the hill where it is exposed in prospect pits. Host rock here appears to be recrystallized limestone + wollastonite or tremolite. Red garnets are locally present. Massive veins of hematite, goethite, and other Fe-oxides may contain malachite stains indicating the presence of former Cu-sulfides.

Aplite and rhyolite porphyry dikes (Trp), fine grained granite (Tfgr), and granite porphyry (Tgp) are well exposed in the vicinity of the Iron King mine, though it is difficult to envision that they would have produced such a mafic skarn, given the whole geological context of the West Tintic mining district. Collectively, the two Iron King shafts may reflect a single zoned skarn, with both a well-developed endoskarn and exoskarn. The West Tintic quartz monzonite is most likely the responsible intrusion for both endoskarn and exoskarn.

Immediately above the Iron King shafts is the best exposure of rhyolite porphyry (Trp) in the West Tintic district (fig. 3). The rhyolite porphyry displays its typical sugary to aphanitic groundmass and sparse, stunted phenocryst population at this location. Outcrops of rhyolite porphyry and aplite almost always have a near vertical dike form, trend northeasterly, and are highly fractured and jointed, though the rock itself remains quite dense. The Iron King rhyolite porphyry grades into fine grained granite (Tfgr) to the southwest. Near the transition into granite, the rhyolite porphyry displays spectacular quartz +/- magnetite stockwork veining and fine laminations of crenulate quartz banding. If a major porphyry Cu-Mo system at depth were responsible for this veining, one might expect to see some hint of "ore" in these quartz stockwork veins. None was found. The evolved rhyolite porphyry at this transition location strongly resembles a phenocryst poor phase of the Urad porphyry from the major Henderson molybdenum deposit in the Colorado mineral belt.

STOP 3: THE WALL, GREAT EASTERN HOLLOW: XENOLITHS OR SOME MAGMA MIXING?

The Wall exposure (fig. 3) indicates either highly variable xenolith types at depth, or multiple, complex, subsurface magma chambers of differing magma composition. At least three units are included in the West Tintic quartz monzonite (Tqm) at this location. The presence of more than one included unit argues in favor of xenoliths, rather than magma mixing. Two of the included units, which do not appear in outcrop in the district, are (1) phenocryst-poor diorite porphyry displaying tear dropped, embayed margins, suggestive of magma mixing and (2) igneous(?) rock of unknown origin displaying a needle-like, felty mat of plagioclase, hornblende, biotite, quartz, and K-feldspar (diktytaxitic texture), and containing local concentrations of sphene. The latter might be replaced ("granitized") Paleozoic carbonate rock; alternatively, it may represent earlier crystallized igneous rock, now unrecognizable after partial assimilation and total recrystallization during transport in Tqm magma. Perhaps these two included units are vestiges of units exposed at Desert Mountain. The third unit included in the West Tintic quartz monzonite, interestingly, is similar to the cross-cutting dike described in the following paragraph.

The Wall of Tqm also exposes a steeply dipping, cross-cutting dike of quartz monzonite porphyry (Tqmp). This dense Tqmp unit, with its distinct light gray groundmass and sparse, but euhedral phenocrysts, is present in much greater quantity along strike to the northeast (fig. 3). Perhaps the most diagnostic feature of Tqmp are the infrequent, but perfectly euhedral, pink K-feldspar phenocrysts. Also diagnostic is the extraordinarily fresh appearance of Tqmp, given the state of other intermediate composition intrusive rock in the district.

Proceeding a short distance south along the Great Eastern Hollow drainage (fig. 3), several outcrops of severely altered West Tintic quartz monzonite (Tqm) are exposed. The waxy feel and intense green color plus the presence of swelling clays indicate strong sericitization and argillization of Tqm, respectively. This pervasive argillic and sericitic alteration suggests that another intrusion is at depth but lies very close to the surface. In fact, the hill just east of this drainage contains exposures of the top of the fine grained granite intrusion (Tfgr), including some pegmatitic and vein dike phases, if one searches the hillside carefully (fig. 4).

STOP 4: THE SOUTHWEST TOE: ALTERED WEST TINTIC QUARTZ MONZONITE AND EXPOSURES OF FINE GRAINED GRANITE AND COPPER OCCURRENCES

At the Southwest Toe location (fig. 3), the top of the granite system is exposed. Prior to our recent mapping, exposures of outcropping fine grained granite (Tfgr) had not been mapped, though a subsurface "white granite" facies was known from company drilling projects related to Cu-Mo exploration (Hal T. Morris, written communication, 1987). In general, drill holes intersected fine grained granite at a depth of several hundred feet in the south-central and southwest part of the main West Tintic quartz monzonite pluton. The fine grained granite is well and extensively exposed in the Southwest Toe; it displays its typical equigranular, fine grained, graphic-looking texture, and has little mafic component.

Alteration at the Southwest Toe is very strong phyllic and marked by quartz veining and flooding plus pyrite, which has created local zones of quartz + Fe-oxide caprock. Sericitization and argillization are generally pervasive. Malachite stains indicate copper ore at the surface. The dump next to an unnamed shaft in this Southwest Toe area (fig. 4) contains relatively high grade stockwork and disseminated chalcopyrite, bornite, and pyrite in fine grained granite. Malachite and chrysocolla are locally spectacular on this mine dump; in addition to vuggy quartz, barite and clear to purple fluorite gangue are also present.

STOP 5: LITTLE BINGHAM: A SUBECONOMIC PORPHYRY Cu-Mo DEPOSIT

A large area of the south-central portion of the exposed West Tintic quartz monzonite (Tqm) consists almost entirely of secondary clay and sericite. The quartz monzonite has been obliterated almost beyond recognition by pervasive alteration, and now appears as an extensive, barren white surface, crumbling and friable, hosting relatively little plant life, and bull-dozed by exploration companies taking assay samples. Copper mineralization is obvious and resembles that of a porphyry copper system such as Bingham. In addition to the destructive argillization and sericitization, potassic alteration, as one might expect, is locally very well developed. This is clearly the "ore zone" (or one of them) of a low-grade, major porphyry Cu-Mo system. Though molybdenum minerals were not actually observed here, drilling indicates that minor molybdenite is present at depth (Hal Morris, written communication, 1987). Together, the Little Bingham and Southwest Toe areas form the approximate center of the porphyry Cu-Mo system estimated to contain about 500 million tons of 0.08% copper (Hal T. Morris, oral communication, 1986).

Stockwork quartz veining, varying from a few mm to about 10 cm width, hosts spectacular azurite + malachite + chrysocolla copper ore in altered West Tintic quartz monzonite (Tqm) host rock. Iron staining indicates the former presence of pyrite in copper veins and as disseminations in Tqm. Secondary hematite is also locally abundant. Barite gangue, common as cm size blades in copper veins, appears to have co-precipitated with copper vein minerals; some examples show barite concentrated along vein margins. Green to purple fluorite is present in the altered Tqm groundmass and in copper veins. This is a spectacular collecting locality for secondary copper carbonates and associated barite gangue.

STOP 6: THE SCOTIA AND WALKER MINES: SEVIER THRUST ASSOCIATED GOLD DEPOSITS?

The Scotia and Walker mines are two of about 25 to 30 mines and prospects in the northeast part of the West Tintic district (fig. 3) that have Au as a main commodity. Nearly all of these Au-producing mines and prospects are located on or near the Sevier age Sheeprock thrust fault (fig. 5). Exposures of the crowded monzonite porphyry (Tcmp), characterized by abundant plagioclase and biotite phenocrysts, are present at many of these mines and prospects. Geochemical data and more detailed field and possibly underground work are needed to definitively relate thrust faults to gold occurrences in the West Tintic district; however, it seems more than a coincidence that the major gold producers in the West Tintic district are nearly all associated with slivers of the Sheeprock thrust.

The Sheeprock thrust fault has placed the Precambrian Sheeprock series on top of folded, steeply dipping, Paleozoic carbonate rocks (figs. 3 and 5). In the West Tintic mining district, multiple thrust slices along the Sheeprock fault produced complex fault slivers within the argillitic and phyllitic units at the base of the upper Precambrian plate. The Scotia and Walker mines are located directly on the slivered Sheeprock thrust fault. Though the visible base metal ore is largely confined to lower plate carbonates in contact with the thrust fault, the discovery pocket of rich gold and silver ore at the Scotia mine was in overlying Precambrian phyllite (Stringham, 1936). In fact, intensely sheared and altered phyllite forms the entrance to the Scotia mine. Crowded monzonite porphyry (Tcmp) is exposed in the powder house at the adjacent Walker mine (fig. 3). The Tcmp is highly chloritized and friable near gold occurrences. Old cross sections of these mines, provided by Centurion Mining Company, indicate that Tcmp is present as small sills in the lower plate, paralleling the Sheeprock thrust, and in some places cuts the upper Precambrian plate. It would be simple to relate Tcmp intrusions to gold occurrences; however, the high grade gold shows a consistent spatial association with the Sheeprock thrust fault. The phyllites at the base of the upper plate exhibit intense hydrothermal alteration and iron staining, suggesting that they may have played a role in the mineralization process other than just serving as caprock for ascending Tcmp intrusions. Interestingly, gold ore occurs in Precambrian series rocks a short distance to the north in the smaller Bluebell district (Hooper, 1969). Furthermore, in thrust-free regions where Tcmp outcrops in Paleozoic rocks of the lower plate, there is generally no suggestion of associated gold occurrences. Thus, a genetic relationship between gold mineralization and phyllites along thrust faults at West Tintic seems clear. This relationship is not meant to imply a Sevier age for gold mineralization; rather, altered Tcmp intrusions in the vicinity of gold-bearing mines along the Sheeprock thrust suggests a late Tertiary age for the formation of gold deposits in West Tintic.

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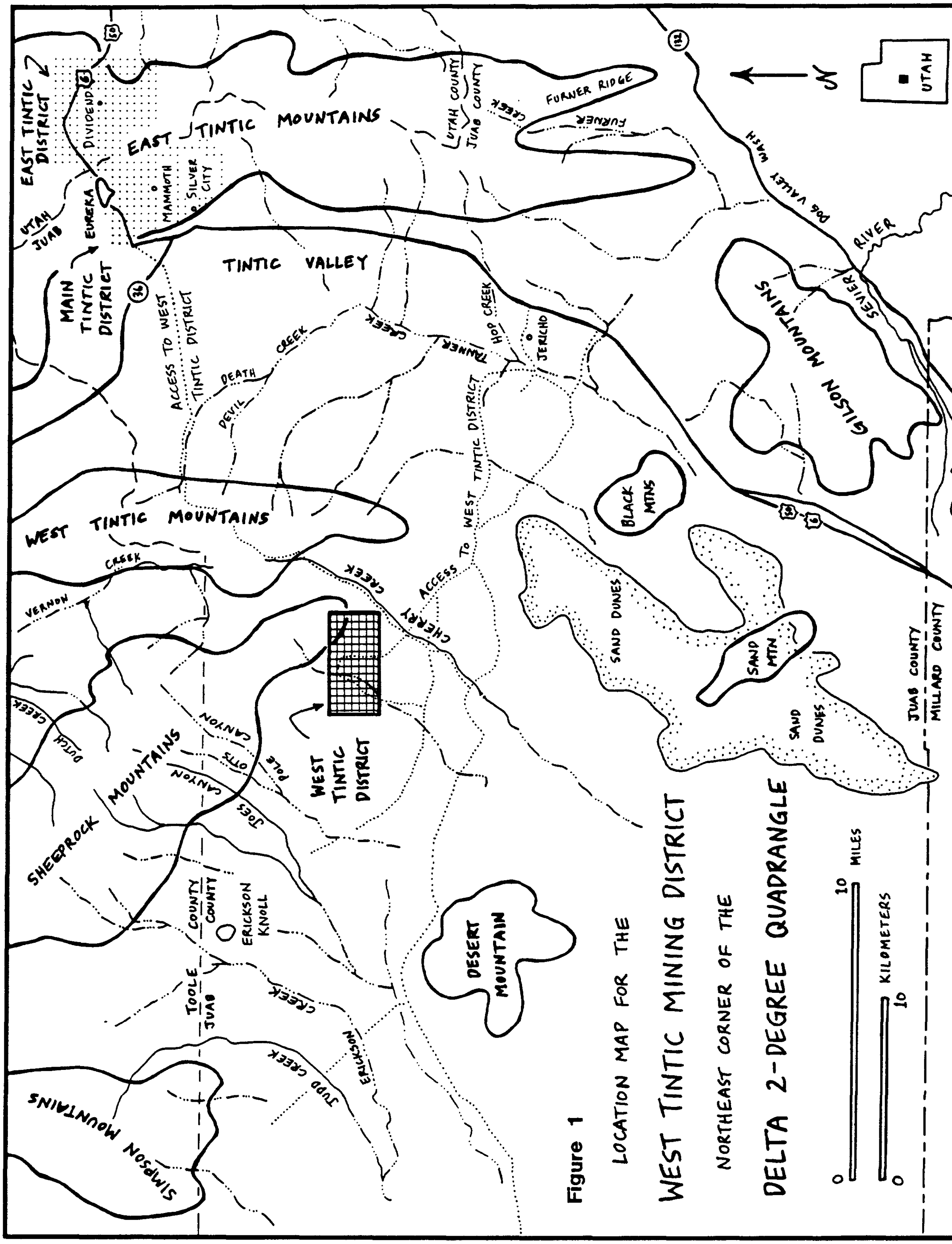


Figure 1

LOCATION MAP FOR THE

WEST TINTIC MINING DISTRICT

NORTHEAST CORNER OF THE

DELTA 2-DEGREE QUADRANGLE

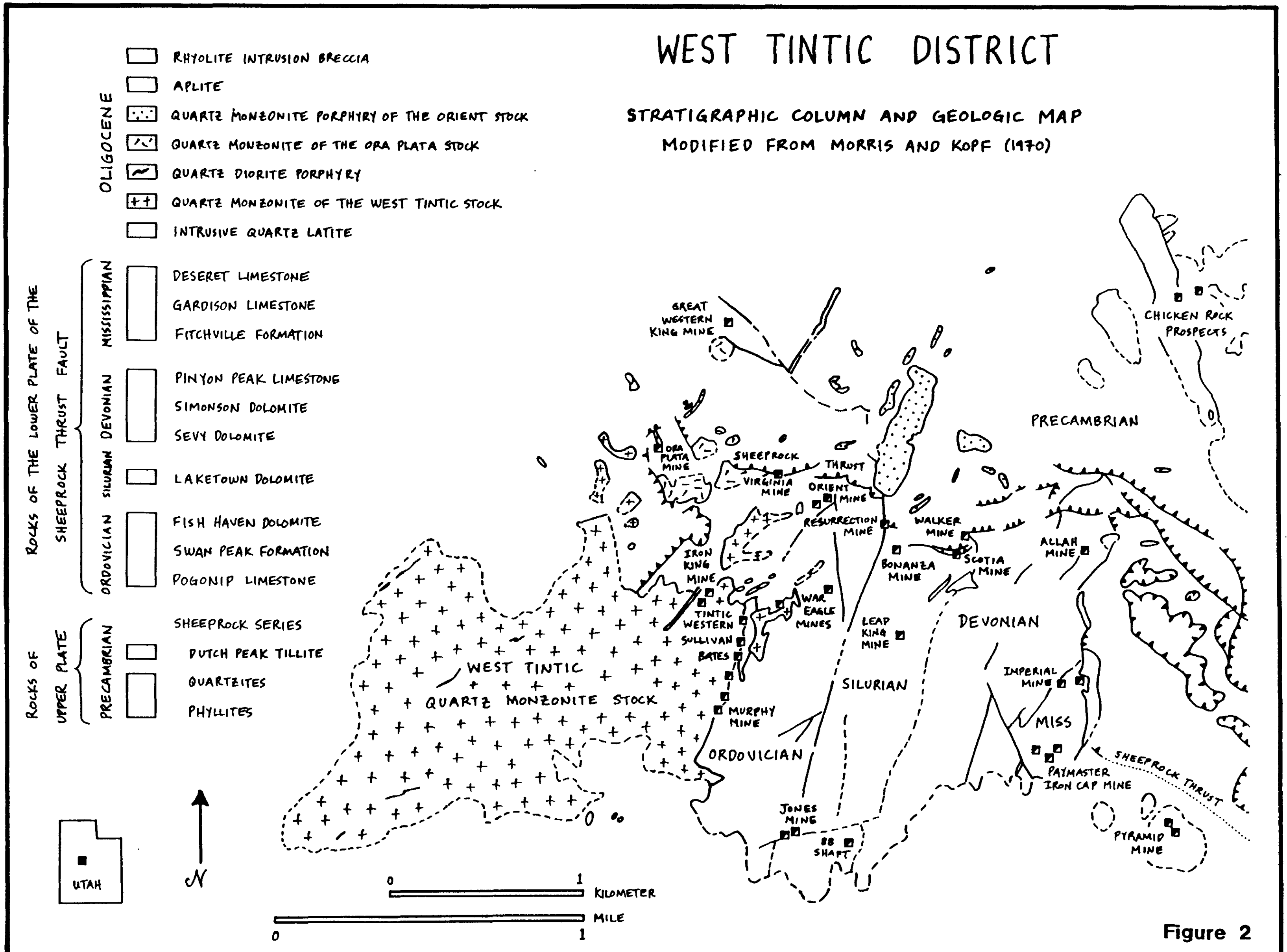
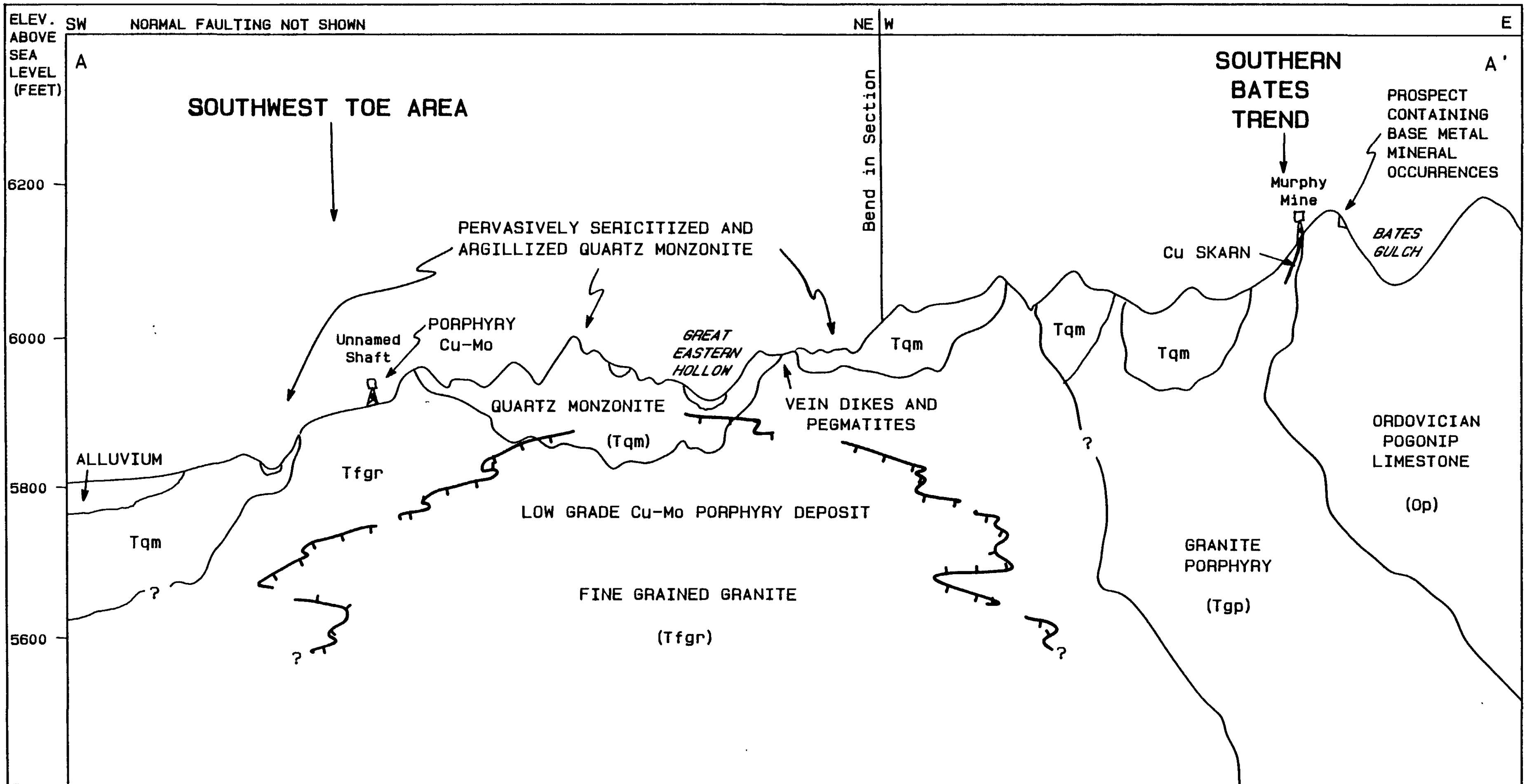

WEST TINTIC DISTRICT
STRATIGRAPHIC COLUMN AND GEOLOGIC MAP
MODIFIED FROM MORRIS AND KOPF (1970)
OLIGOCENE
RHYOLITE INTRUSION BRECCIA
APLITE
QUARTZ MONZONITE PORPHYRY OF THE ORIENT STOCK
QUARTZ MONZONITE OF THE ORA PLATA STOCK
QUARTZ DIORITE PORPHYRY
QUARTZ MONZONITE OF THE WEST TINTIC STOCK
INTRUSIVE QUARTZ LATITE
ROCKS OF THE LOWER PLATE OF THE SHEEPROCK THRUST FAULT
MISSISSIPPIAN
DESERET LIMESTONE
GARDISON LIMESTONE
FITCHVILLE FORMATION
DEVONIAN
PINYON PEAK LIMESTONE
SIMONSON DOLOMITE
SEVY DOLOMITE
SILURIAN
LAKETOWN DOLOMITE
ORDOVICIAN
FISH HAVEN DOLOMITE
SWAN PEAK FORMATION
POGONIP LIMESTONE
ROCKS OF UPPER PLATE
PRECAMBRIAN
SHEEPROCK SERIES
DUTCH PEAK TILLITE
QUARTZITES
PHYLLITES
UTAH
N
GREAT WESTERN KING MINE
CHICKEN ROCK PROSPECTS
PRECAMBRIAN
ORA PLATA MINE
SHEEPROCK
VIRGINIA MINE
THRUST
ORIENT MINE
RESURRECTION MINE
WALKER MINE
SCOTIA MINE
ALLAH MINE
IRON KING MINE
BONANZA MINE
TINTIC WESTERN
SULLIVAN
BATES
WAR EAGLE MINES
LEAP KING MINE
DEVONIAN
WEST TINTIC QUARTZ MONZONITE STOCK
MURPHY MINE
SILURIAN
IMPERIAL MINE
MISS
ORDOVICIAN
PAYMASTER
IRON CAP MINE
SHEEPROCK THRUST
JONES MINE
88 SHAFT
PYRAMID MINE
0
1
KILOMETER
MILE
0
1

Figure 2

Figure 3

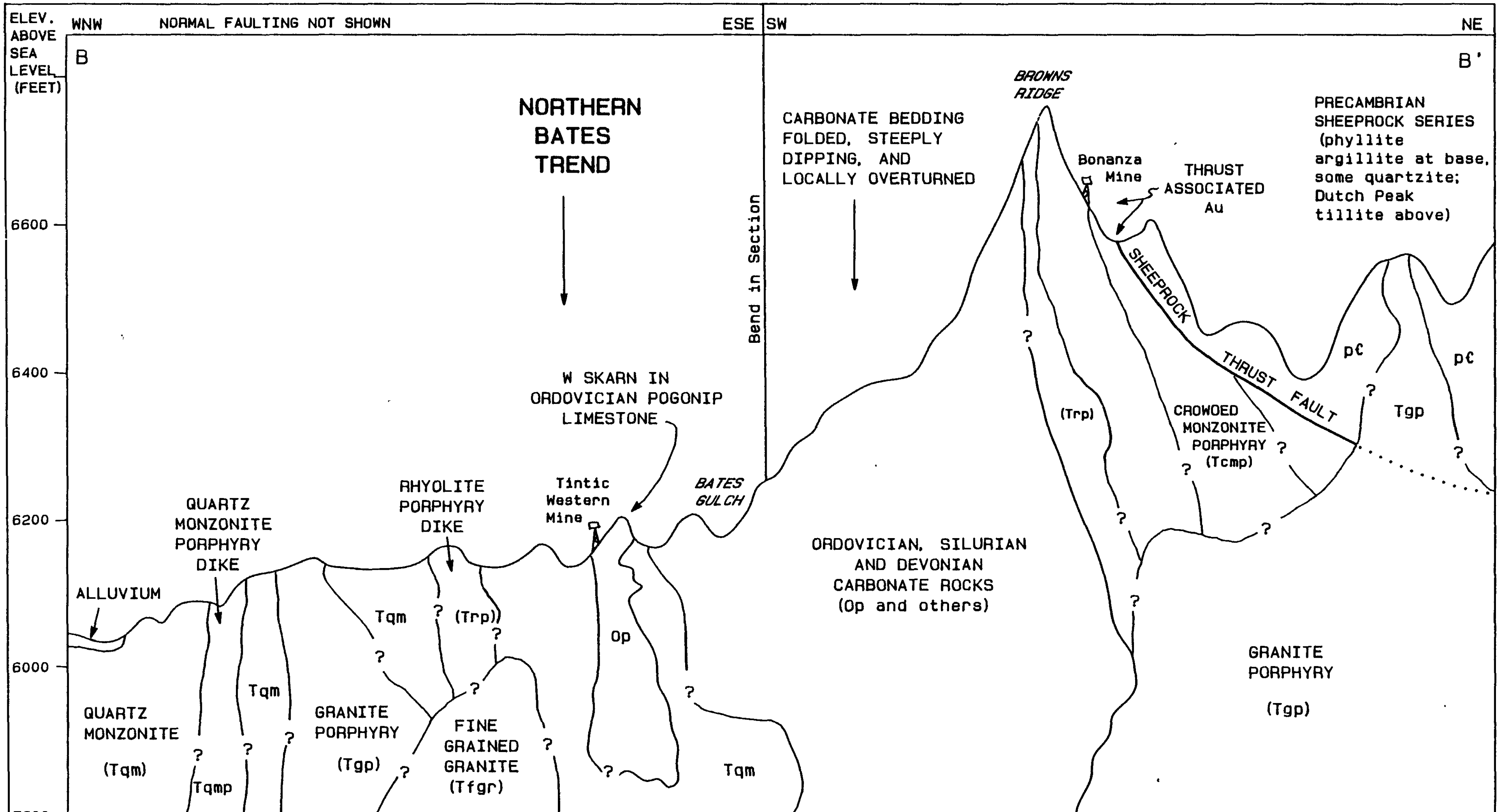
in pocket



GENERALIZED CROSS-SECTION THROUGH SOUTHERN PORTION OF THE WEST TINTIC MINING DISTRICT, JUAB COUNTY, WESTERN UTAH

Figure 4

VERTICAL EXAGGERATION = 5X HORIZONTAL: 1:12000 or 1 INCH = 1000 FEET VERTICAL: 1 INCH = 200 FEET



GENERALIZED CROSS-SECTION THROUGH NORTHERN PORTION OF THE WEST TINTIC MINING DISTRICT, JUAB COUNTY, WESTERN UTAH

Figure 5

VERTICAL EXAGGERATION = 5X HORIZONTAL: 1:12000 or 1 INCH = 1000 FEET VERTICAL: 1 INCH = 200 FEET