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1991, pp. 283-290. https://doi.org/10.56577/FFC-42.283

in:

Geology of the Sierra Blanca, Sacramento, and Capitan Ranges, New Mexico, Barker, J. M.; Kues, B. S.; Austin, G. S.; Lucas, S. G.; [eds.], New Mexico Geological Society 42 nd Annual Fall Field Conference Guidebook, 361 p. https://doi.org/10.56577/FFC-42

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TECTONO-METALLOGENIC MAPS OF MINING DISTRICTS IN THE LINCOLN COUNTY PORPHYRY BELT, NEW MEXICO

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Abstract—Tectono-metallogenic maps of the Nogal-Bonito, White Oaks, Jicarilla, Schelerville (West Bonito), Capitan Mountains, and Tecolote mining districts show structures, rock units, and mineral deposits in such a way that inferences can be made about controls of mineralization and exploration targets can be defined. Principal structural elements include faults, fracture or shear zones, breccia zones, and folds. Rock units shown on the maps emphasize favorable hosts for mineralization. Lithologic factors influencing the potential to host mineral deposits include mechanical behavior (i.e., brittle or ductile) and chemical favorability for replacement or metasomatism. Intrusive igneous rocks are shown as felsic, intermediate, or mafic, and in some cases alkalic; the composition appears to be a major factor in the genesis of many associated minerals deposits. Mineral occurrences show metals and the type of deposit (e.g., vein, contact metasomatic, disseminated, shear zone-hosted, breccia-hosted, stockwork, or placer). The Lincoln County porphyry belt is part of an early to mid-Tertiary alkalic igneous province extending from west Texas to central-northern Montana. This province is characterized by silica-undersaturated to silica-saturated rocks with associated metallic mineralization, especially gold. Total gold production from the Lincoln County belt is at least 186,000 oz.

INTRODUCTION

Tectono-metallogenic maps depict relationships between structures, rock units, and mineral deposits so that inferences can be made about controls of mineralization. This kind of map provides a large amount of data in a convenient manner and thus serves as an idea map for generating exploration targets.

The maps in this report are taken from a series of 1:62,500-scale tectono-metallogenic maps covering the entire Lincoln County porphyry belt. Only the areas of the more important mining districts are shown here because the complete maps would be expensive to publish and large areas between the districts are of little interest. Also, a tectono-metallogenic map of the Gallinas mining district is presented by Woodward and Fulp (this volume) and therefore is not included here.

Total value of minerals, including coal, produced from Lincoln County from 1882 through 1953 was estimated to have amounted to about $5.5 million at the time of production (Griswold, 1959). Ranked according to value, the metals and minerals are gold, coal, iron ore, lead, copper, silver, tungsten, fluorspar, bastnaesite and zinc. Using the values reported by Griswold (1959, p. 19–22), total gold production is estimated to be 162,500 oz. North and McLemore (1986), however, suggested that total gold production is about 186,000 oz.

STRUCTURAL BEHAVIOR OF ROCKS

Deformation of host rocks for mineral deposits in this region occurred mainly during the Cenozoic under low to moderate confining pressures and low to high temperatures, generally related to proximity to igneous intrusions. Competent rocks tend to be brittle and form open spaces for mineral deposition whereas plastic or ductile behavior results in lack of open spaces.

Crystalline basement rocks of Precambrian age are competent and are characterized by brittle behavior. These rocks, however, do not commonly host mineral deposits in the Lincoln County porphyry belt because the intrusive rocks that are inferred to be genetically associated with mineralization are emplaced and exposed at stratigraphic levels above the Precambrian. Paleozoic strata, mainly of Permian age, consist of sandstone, mudstone, gypsum, and carbonates. The sandstones and carbonates are less competent than the basement rocks, but also have undergone brittle deformation. Mudstone and gypsum are weak and deform plastically.

Mesozoic and early Tertiary strata are dominantly shale and mudstone, with subordinate sandstone, coal, and conglomerate. The incompetent shales and mudstones tend to deform plastically, as does the coal. Sandstone and conglomerate are more competent and hence more brittle. Where contact metamorphosed, the shales have become brittle and form fissures and breccias with interstitial porosity.

Tertiary volcanic and intrusive rocks are mostly competent and brittle, forming fissures, breccias, and shears that may be mineralized. Quaternary and/or late Tertiary basalts are also competent, but do not host ineral deposits, as they postdate the main mineralization. Surficial sediments locally host gold placers, but do not host epigenetic metallic deposits.

TECTONICS

The Lincoln County porphyry belt consists of scattered stocks and laccoliths in an area extending about 110 km from High Rolls on the south to the Gallinas Mountains on the north (Fig. 1). This belt is mostly less than 40 km east-west except for the pronounced eastward salient of the Capitan Mountains pluton.

Many of the plutons are composed of mid-Tertiary alkalic rocks and form part of a larger alkalic province extending from west Texas to north-central Montana (Barker, 1974). The Lincoln County belt lies between the Rio Grande rift, characterized by thinned crust (28–35 km), and the Great Plains province where the crust is about 45–50 km thick (Keller et al., 1989).

The principal tectonic elements in the Lincoln County porphyry belt are the Sierra Blanca Basin, the Mescalero arch, the Sacramento uplift, the Tularosa Basin, and the Pecos slope. Descriptions of these features are taken mainly from Kelley and Thompson (1964).

Sierra Blanca Basin

The Sierra Blanca Basin trends northerly and is about 60 km long and 40 km wide. The basin is slightly asymmetric, with a steep eastern limb and a gently dipping western flank. Maximum structural relief between the basin and the Mescalero arch to the east is at least 1200 m. The western limb of the basin grades into the eastern dip-slope of the Oscura uplift, beyond the area shown on Fig. 1. To the south, the basin merges with the Sacramento uplift. Within the area of Fig. 1 the Claunch sag appears to be a northerly continuation of the Sierra Blanca Basin. Regionally, the sag extends northward to the Estancia Basin. The southwestern part of the Sierra Blanca Basin may merge with the Tularosa Basin. Only the northeastern part of this latter basin is present in the area of interest.

Folds and faults locally modify the form of the Sierra Blanca Basin. Most notable are north-plunging anticlines in the southern part of the basin and a north-northeasterly trending fault zone near Ruidoso. This fault zone has about 365 to 425 m of stratigraphic separation.

Although the Sierra Blanca Basin is the structurally deepest area in

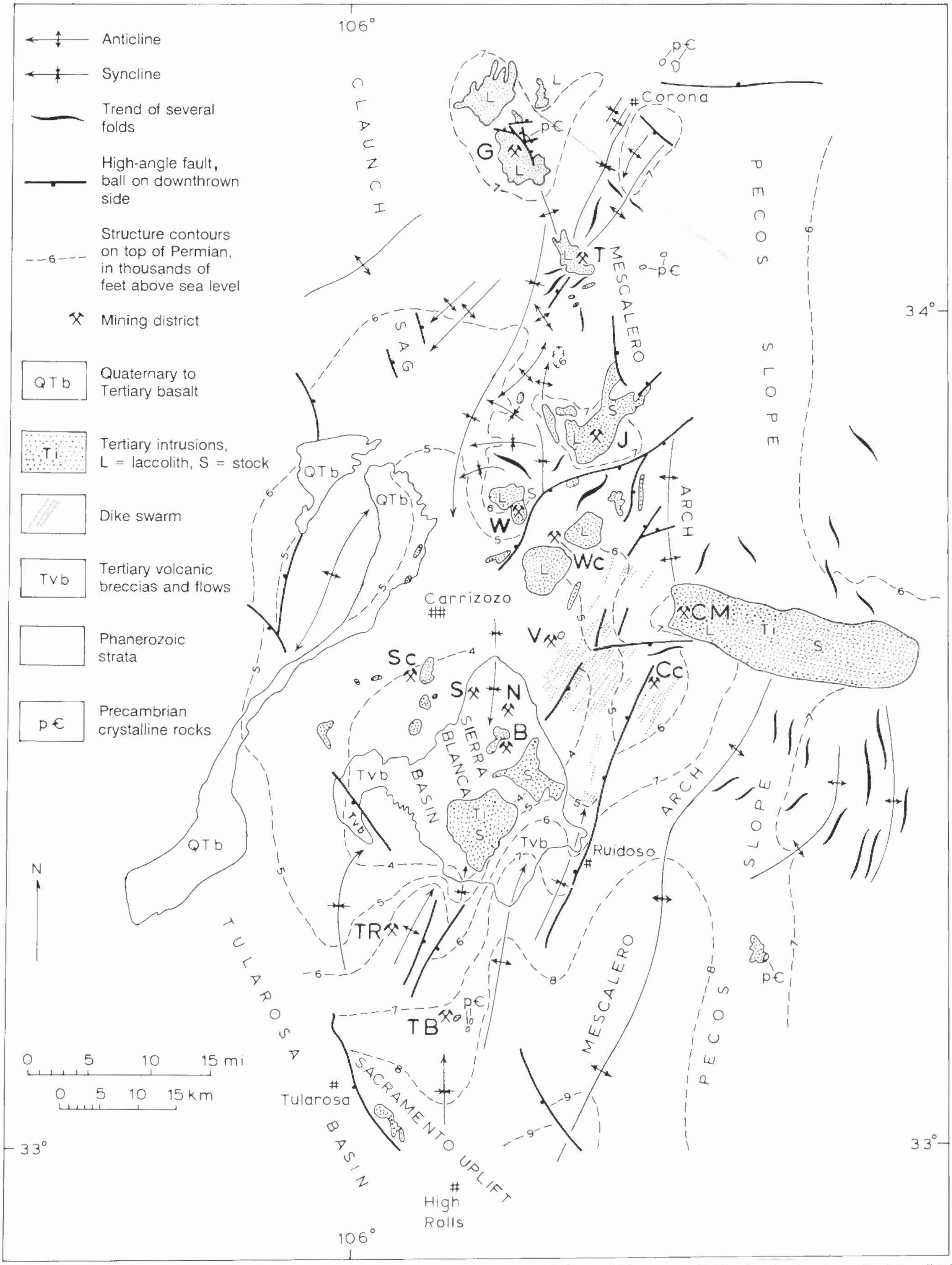

FIGURE 1. Generalized tectonic map of the Lincoln County porphyry belt (modified from Kelley and Thompson, 1964), showing locations of mining districts (B = Bonito; Cc = Capitan coal; CM = Capitan Mountains; G = Gallina; J = Jicarilla; N = Nogal; S = Schelerville or West Bonito; Sc = Sierra Blanca coal; TB = Tularosa or Bent; TR = Three Rivers; W = White Oaks; Wc = White Oaks coal; and V = Vera Cruz sub-district).

the Lincoln County porphyry belt, it is also the topographically highest because of a great thickness of volcanic rocks and the presence of two major stocks (Thompson, 1966).

Mescalero arch

The Mescalero arch plunges gently to the north-northeast from the Sacramento uplift to its truncation by the Capitan Mountains intrusion. The arch is about 425 m lower on the north side of the Capitan Mountains and is offset about 15 km to the west. North of the Capitan Mountains the arch is not as well defined, but appears to continue north-northwesterly to the Tecolote and Gallinas intrusive centers. The eastern limb of the arch is marked by the gently dipping Pecos slope, and the western flank merges with the Sierra Blanca Basin and the Claunch sag. Stocks, laccoliths, faults, and folds locally modify the northern part of the arch, making it irregular in trend and somewhat obscure.

Sacramento uplift

Only the northern end of the Sacramento uplift is shown on Fig. 1. The uplift is a broad, gently east-tilted fault block with an overall northerly trend. As noted previously, the Mescalero arch extends north-northeasterly from near the crest of the Sacramento uplift. Pray (1961, p. 124–125) indicated that the uplift is separated from the Tularosa Basin on the west by a zone of normal faults having at least 2100 m of stratigraphic separation near the central part of the uplift (not shown on Fig. 1).

MINING DISTRICTS

Discussions of the following mining districts of the Lincoln County porphyry belt are intended to show the styles of mineralization for the accompanying tectono-metallogenic maps rather than give detailed descriptions of the various deposits, as numerous descriptions are readily available in the references cited below. Maps for the Tularosa (Bent), Three Rivers, Sierra Blanca coal, and Capitan coal mining districts are not included. The coal-producing districts are outside the scope of this paper and the Three Rivers and Tularosa districts appear to be structurally simple and small. A small iron deposit consisting of magnetite with calcite and barite is present in the Three Rivers district (Kelley, 1949). The Tularosa district is characterized by low-grade copper deposits hosted by the Permian Abo Formation near a diorite porphyry intrusion. Also, the Gallinas district is not included because it is discussed elsewhere in this volume (see paper by Woodward and Fulp).

White Oaks district

The White Oaks district (Fig. 2) is characterized by epithermal quartz-adularia-gold mineralization and has accounted for the vast majority, about 163,000 oz, of the gold produced from the Lincoln County porphyry belt. The lode deposits are mainly narrow, northerly trending quartz-pyrite veins, sheeted fractures, and zones of brecciation hosted by a trachyte-syenite porphyry breccia pipe, hornfelsed Cretaceous shale, and lamprophyre dikes (Lindgren et al., 1910; Griswold, 1959; Grainger, 1974). The veins are mostly narrow stringers, but where abundant and closely spaced they constituted ore bodies (Lindgren et al., 1910, p. 180). Some of the gold was deposited in breccia zones, with widths as much as 6 m.

Tungsten, in the form of huebnerite, is found in the gold-bearing veins. Although there are no records of tungsten production from the White Oaks district, Griswold (1959, p. 40–41) estimated that about 120,000 lbs of WO_3 concentrate was produced.

Contact metasomatic iron deposits are present along the margins of the Lone Mountain laccolith (Fig. 2) where Permian carbonate beds have been replaced. The Yellow Jacket mine is credited with 30% of the total iron production of Lincoln County (Kelley, 1949, p. 153). This mine is unusual with respect to most of the iron deposits in Lincoln County because hematite rather than magnetite is the principal ore mineral. The House mine contains minor amounts of uranium in the form of metatorbernite (Walker and Osterwald, 1956) with the principal ore mineral magnetite.

Jicarilla district

The Jicarilla district (Fig. 2) is mostly underlain by a laccolith of granodiorite that intrudes Permian strata (Segerstrom and Ryberg, 1974). A mafic stock lies east of this pluton and numerous sills cut the Permian beds. The most abundant metallic deposits are contact replacement iron ore deposits in limestone of the Permian San Andres Formation and gold placers (Ryberg, 1968; Griswold, 1959).

Magnetite and subordinate hematite occur mostly as replacements up to 3 m thick along bedding adjacent to the plutons, although some deposits appear to be hosted by intrusive rocks. Production was about 8000 tons and took place in 1918–1921 and 1942–1943 (Kelley, 1949).

Placer gold is found in Quaternary alluvium and in Tertiary fanglomerate. Segerstrom and Ryberg (1974) estimated that the auriferous fanglomerate has an areal extent of about 13 to 15.5 km^2 with an average thickness of 5 m. Near the upstream end of the fanglomerate an area of about 420 acres (170 hectares) was estimated to contain about 5,400,000 cubic yards of material averaging 0.043 oz gold per cubic yard.

The placer gold was derived locally from disseminations, narrow veinlets, and stockworks hosted by intrusive rocks that contain auriferous pyrite and specularite along with arsenopyrite, chalcopyrite, sphalerite, galena and gold (Segerstrom and Ryberg, 1974). There is very little detailed published information concerning the size and grade of the lode-gold deposits. Lindgren et al. (1910) reported that some of the lodes are only a few centimeters wide, but a few carry low-grade gold values over widths of 12 m or more. Narrow veinlets gave assays as high as 20 oz per ton gold and the wider ore bodies may have ranged from 0.06 to 0.675 oz/ton (Lindgren et al., 1910, p. 183).

Most of the gold production was from placers (Jones, 1904; Lindgren et al., 1910) with an estimated total of about 5500 to 8500 oz (Lasky and Wootton, 1933; Segerstrom and Ryberg, 1974; North and McLemore, 1986). Lode-gold production is credited to the district only for 1933 when 82.62 oz was reported (Segerstrom and Ryberg, 1974).

Nogal, Bonito, and Schelerville (West Bonito) districts

These districts are contiguous and mostly occur around and within the Rialto, Bonito Lake, and Three Rivers stocks (Fig. 3). The principal types of deposits include: (1) gold-copper igneous breccia pipe deposits, (2) epithermal quartz fissure veins with base and/or precious metals, (3) disseminated copper-molybdenum porphyry, (4) gold deposits hosted by brecciated sandstone and shale, and (5) gold placers (Jones, 1904; Lindgren et al., 1910; Griswold, 1959, 1964; Thompson, 1966, 1968, 1973). In addition, Fulp and Woodward (this volume) suggest the presence of a buried alkalic gold-copper porphyry system.

Nearly all the production, estimated by Thompson (1973) to be about $1 million, has come from fissure veins, the Parsons igneous breccia pipe, and brecciated sandstone- and shale-hosted gold deposits. Minor amounts of gold have come from placers. The Parsons mine may have produced about 15,000 oz gold and was probably the largest producer in the district. A few of the fissure veins are as much as 1.5 m wide and 600 m long, but others are only a few centimeters across. Some of the gold-bearing vein deposits, such as the Great Western, are emplaced in sheared or brecciated zones and have the potential of large tonnages.

The Schelerville district (Fig. 3) is characterized by veins that occur mostly at the contacts of east-trending dikes intruding Sierra Blanca Volcanics (Griswold, 1959, p. 73). The veins are fissure fillings and rarely attain 1 m in width; production of copper, lead, and precious metals was minor.

The Vera Cruz mine (Fig. 3), outside the main part of the district, was considered a sub-district by Lindgren et al. (1910). It appears to differ from the gold deposits in the main part of the Nogal-Bonito district because the host is a breccia pipe containing fragments of sandstone and shale of the Cretaceous Mesaverde Formation together with rare clasts of brecciated intrusive rock. This deposit is of interest because of its similarity to the Ortiz (Cunningham Hill) gold mine operated by Gold Fields during the 1980s in the Ortiz (Old Placers) district near Madrid, New Mexico (Wright, 1983).

A molybdenum-copper porphyry system in the northern part of the Rialto stock has been explored but not developed (Thompson, 1973,

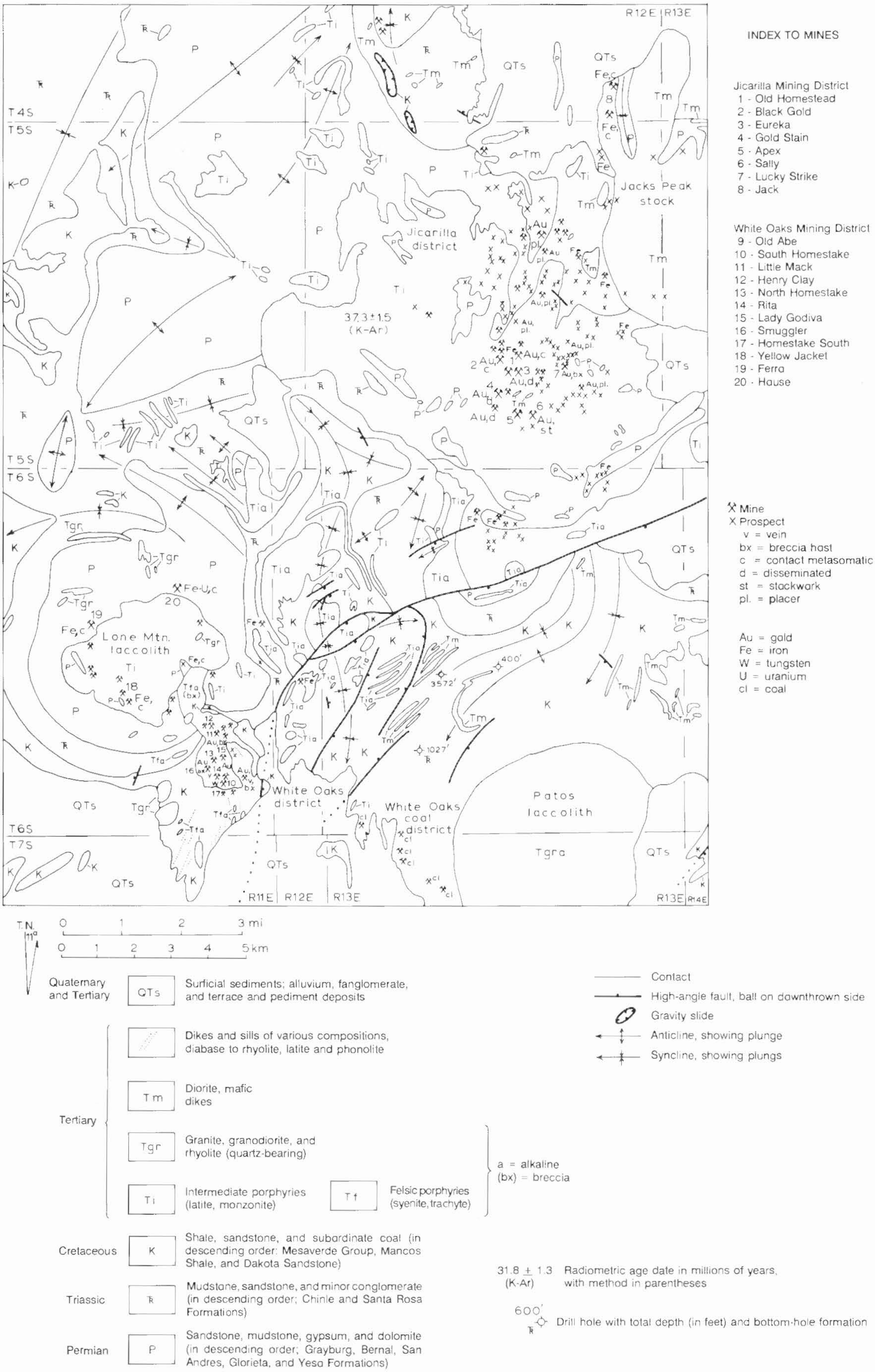

FIGURE 2. Tectono-metallogenic map of the White Oaks and Jicarilla mining districts. Modified from Grainger (1974), Griswold (1959), Haines (1968), Kelley (1971), Ryberg (1968), Segerstrom and Ryberg (1974), Smith and Budding (1964) and Weber (1964).

T. N. 11° M.N.
0 1 2 3 mi
0 1 2 3 4 5 km

INDEX TO MINES

Nogal-Bonito Mining District
1 - Vera Cruz
2 - Helen Rae-American
3 - Rialto
4 - Parsons
5 - Renowned
6 - Old Red Fox
7 - Old Abe
8 - Spur
9 - White Swan
10 - Bailey
11 - Argentine
12 - Willis
13 - Silver Spoon
14 - Maude
15 - Greenville
16 - Great Western
17 - Washington
18 - Silver Nugget
19 - Christmas
20 - Soldier
21 - Hope
22 - Mineral Farms Canyon
23 - Mayberry
24 - Rock No. 1
25 - Blue Jay
26 - Silver Plume
27 - McCrory
28 - Turkey Creek
29 - Creek Lead, Monjeau No. 1, Osa
30 - Water Dog

Schelerville (West Bonito) Mining District
31 - Homestake
32 - Commercial
33 - Junction
34 - Idaho
35 - New Mexico Copper
36 - New Mexico Copper

⚒ Mine
X Prospect
v = vein
bx = breccia
sh = shear zone
d = disseminated

Au = gold
Ag = silver
Cu = copper
Mo = molybdenum
Pb = lead
Zn = zinc
Ba = barite
cl = coal

QTs — Surficial sediments: alluvium, fanglomerate, and terrace and pediment deposits

Dikes and sills of unknown compositions

Ti — Intermediate porphyries (latite, monzonite, andesite)

Tf — Felsic porphyries (trachyte, syenite, nordmarkite)

a = alkalic
bx = breccia

Tvb — Volcanic flows, flow breccia, agglomerate, and tuff; andesite to rhyolite (Sierra Blanca Volcanics)

TK — Synorogenic sediments: mudstone, arkosic sandstone, and conglomerate (McRae = Cub Mountain Formation)

K — Shale, sandstone, coal, and limestone (in descending order: Mesaverde Formation, Mancos Shale, and Dakota Sandstone)

Contact
High-angle fault, ball on downthrown side
Shear zone
Anticline, showing plunge
Syncline, showing plunge

Geochemical anomalies:

A_{Mo} — letter (A-E) corresponds to use in U.S.G.S. Bull. 1453; anomalous element (REE = rare earth elements and related elements)

Drill hole

26.6 ± 1.1 (K-Ar) — Radiometric age date, in millions of years, with method in parentheses

FIGURE 3. Tectono-metallogenic map of the Nogal, Bonito, and Schelerville (West Bonito) mining districts. Modified from Kelley (1971), Thompson (1966), Segerstrom et al. (1979) and Moore et al. (1985, 1986).

p. 10–12). A buried alkalic gold-copper porphyry system in the northern part of the Bonito Lake stock is proposed by Fulp and Woodward (this volume) on the basis of concentric alteration zones, geochemical anomalies, and the presence of silica-limonite breccias suggesting acid leaching.

Capitan Mountains district

Iron ore and thorium deposits are found in this district (Fig. 4), but there appears to have been no major production. The iron deposits occur as magnetite and hematite replacements of Permian carbonate strata near intrusive rocks (Griswold, 1959). Kelley (1949, p. 151) interpreted the controlling structure of the Capitan deposits to be a pre-ore, pre-intrusion collapse structure or sinkhole. A few other iron ore deposits occur in the northeastern part of the Capitan Mountains, outside the area covered by the tectono-metallogenic map of the Capitan Mountains district.

Thorium is present in allanite in breccia veins cutting microgranite of the Capitan Mountains laccolith (Griswold, 1959, p. 90). Lanthanum,

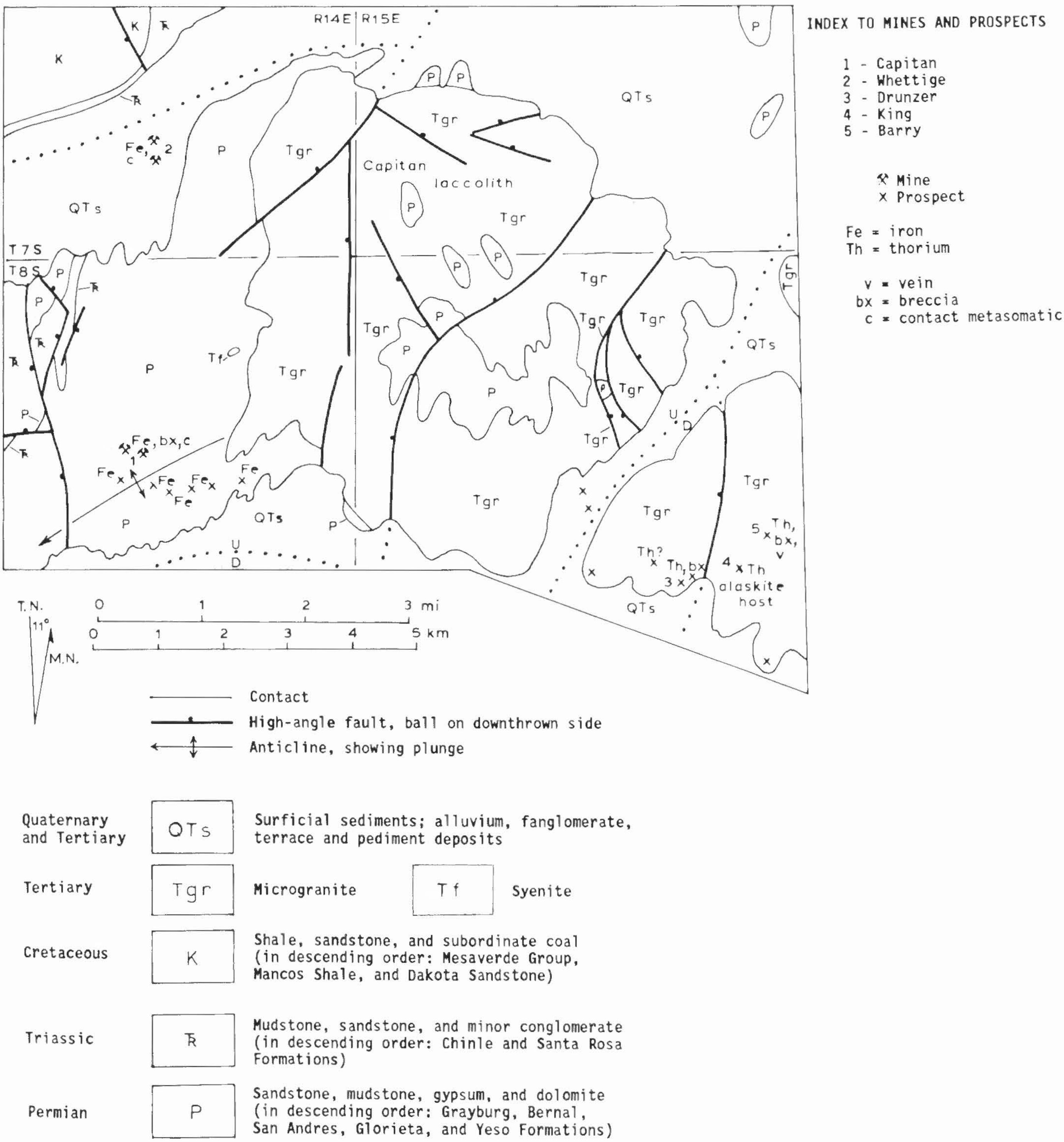

FIGURE 4. Tectono-metallogenic map of the Capitan Mountains mining district. Modified from Kelley (1949, 1952, 1974) and Griswold (1959).

cerium, and yttrium are also found in the allanite (McLemore et al., 1988). The veins are up to 0.3 m wide and contain breccia fragments of microgranite with interstitial quartz, fluorite, tourmaline and iron oxides.

Tecolote district

Contact metasomatic iron bodies occur as replacements of Permian limestone adjacent to monzonite and diorite of the Tecolote laccolith (Kelley, 1949; Rawson, 1957; Griswold, 1959). In addition to this pluton, there are smaller laccoliths and associated dikes and sills. Emplacement of the laccoliths created numerous associated folds (Fig. 5). A few northeast-trending faults with minor displacements are present and locally offset some of the intrusions.

Magnetite and subordinate hematite form tabular deposits up to 3 m thick with iron content of 45–55% (Rawson, 1957). About 14,750 short tons (13,380 metric tons) of iron ore were shipped from the district, with nearly all production from the Elda mine during 1915 to 1919 (Kelley, 1949).

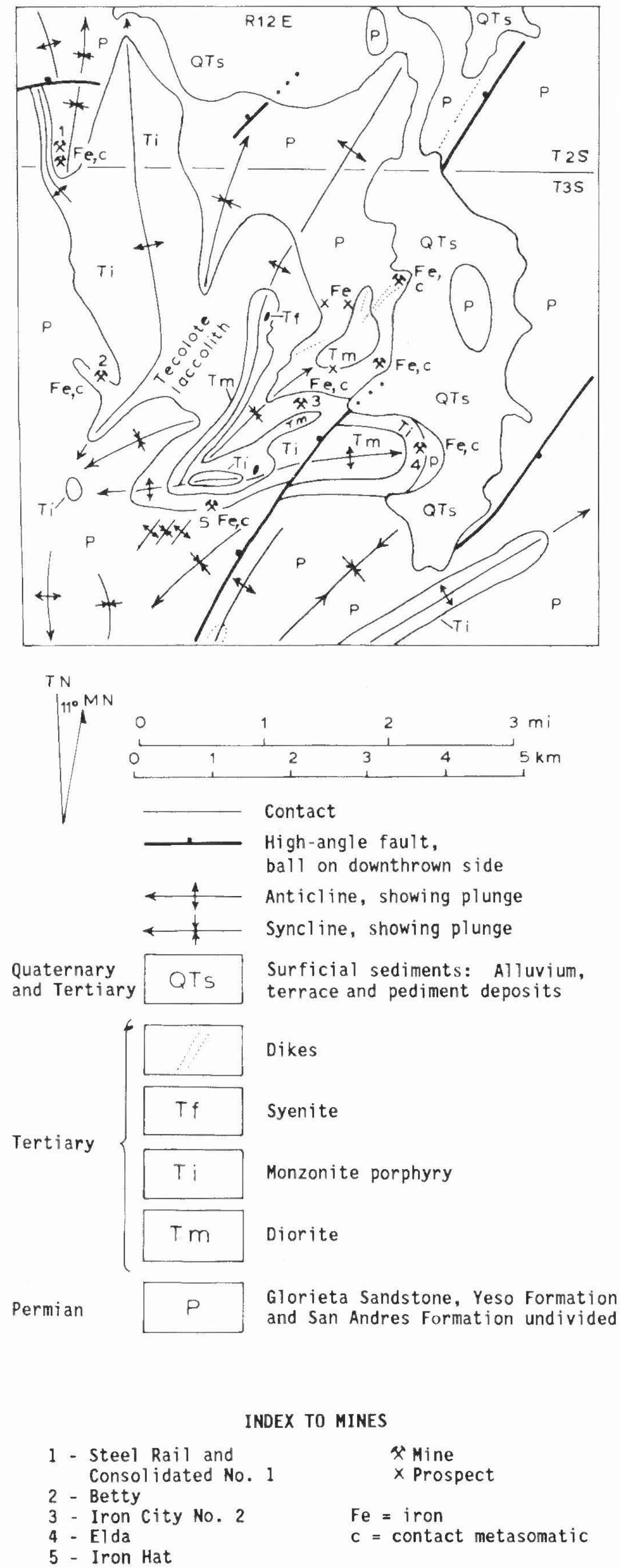

FIGURE 5. Tectono-metallogenic map of the Tecolote mining district. Modified from Kelley (1972) and Rawson (1957).

ACKNOWLEDGMENTS

I thank Craig J. Nelsen and LAC Minerals (USA), Inc. for permission to publish these maps. Michael S. Fulp and J. Leroy Schutz reviewed the paper and made many helpful comments.

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View to the east up toward Cloudcroft along the railroad right-of-way. Note the high bridge at top of view and road crossing in foreground. From the postcard collection of Spencer Wilson.