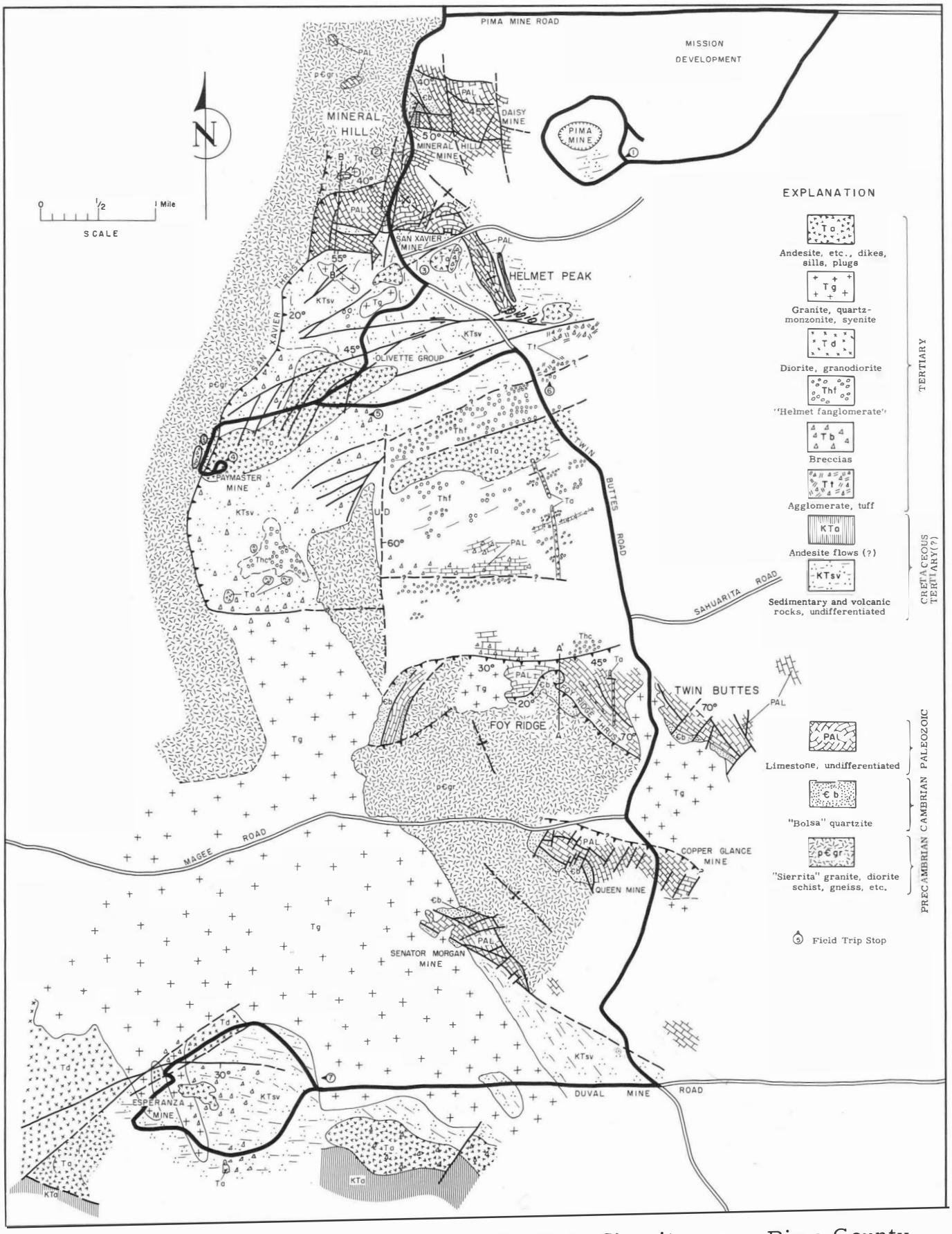

FIGURE 44. Generalized geologic map of the East Sierrita area, Pima County, Arizona, showing part of route of Field Trip I and location of cross sections (figs. 41A, B; 42B).

STRUCTURE AND ORE DEPOSITS OF THE EAST SIDE OF THE SIERRITA MOUNTAINS

TRIP I, ROAD LOG

Thursday, April 2, 1959

Leaders: W. C. Lacy and S. R. Titley

Driving distance: 90.3 miles. Logged distance: 56.6 miles.

General Statement

The east side of the Sierrita Mountains (Lacy, 28), hereafter referred to as the East Sierrita area, has been the subject of intense interest and organized study on the part of mining companies for the past eight years and as a consequence, it has yielded three new major copper ore bodies - the Pima mine, the Mission development and Esperanza mine. These properties all depart somewhat from the usual character of "porphyry copper" deposits and open the possibilities for additional discoveries.

The structural environment of these ore bodies is exceedingly complex and there is no general agreement as to either the character of the structural elements or the chronology of events. All features appear to reflect continued left-lateral movement along a west-northwest direction.

The field trip route leads south from Tucson to the eastern slope of the Sierrita Mountains where isolated hills rise above the bajada to reveal a kaleidoscopic version of the underlying geology.

The starting point of the road log is the Third Street entrance to the University of Arizona at Park Avenue. The caravan will disband after the Esperanza mine stop and individual parties may return to Tucson immediately, or, if they prefer, remain to visit additional points of interest along the route.

0.0	0.0	Intersection of Park Avenue with Third Street at entrance to the University of Arizona. Follow Park Avenue southward.
7.0	7.0	TURN RIGHT, follow Valencia Road.
0.7	7.7	4-way STOP SIGN. At 2:00, the southern Tucson mountains, composed essentially of strongly deformed Cretaceous arkose and shale and Tertiary intrusive and volcanic rocks. Enter area shown on figure 29.
2.8	10.5	TURN LEFT, follow south on Mission Road. Enter San Xavier Indian Reservation.
1.9	12.4	STRAIGHT AHEAD, follow Twin Buttes Road. Mission Road turns off to the left to Mission San Xavier del Bac. At 2:00, Black Mountain, a lava capped mesa which rises 1,000 feet above its base to an altitude of 3,703 feet (fig. 40B). In ascending order it is composed of speckled rhyolite, "San Xavier conglomerate beds," andesite porphyry and thin basalt and andesite flows, all of middle (?) Tertiary age. Most of the San Xavier Indian Reservation is covered by alluvial deposits which range in age from Tertiary through Quaternary. The older alluvium is encountered widely in well borings. South of Black Mountain, the older alluvium averages about 200 feet thick and appears to have been deposited on a moderately rolling surface with shallow northeast-trending valleys separated by ridges. Southeast and northwest of the reservation, well logs indicate that the alluvium is at least 700 feet thick.
1.2	13.6	At 12:00, the Sierrita Mountains and their northeast-sloping pediment with occasional peaks rising above its surface. Cretaceous arkose and Tertiary volcanic rocks are found west of the road just north of the southern reservation boundary. Heindl (25) proposes a N 60° W fault between these rocks and the Precambrian granites to the south (fig. 29).
7.5	21.1	Leave San Xavier Indian Reservation and area shown on figure 29. Enter area

shown on figure 44. TURN LEFT on Pima Mine Road. You pass over the Mission development (Richard and Courtright, 32) which is under exploration by The American Smelting and Refining Company. (This country has all been solidly staked -- lode and placer -- so put those location notices back in your pocket.)

1.6	22.7	ASARCO Mission development shaft at 3:00. Exploratory drilling began in 1956 and mineralized bedrock was penetrated about 200 feet below the surface (fig. 43). Sulphides, predominantly pyrite and chalcopyrite are distributed erratically as disseminated grains and veinlets through badly fractured, metamorphosed and altered sedimentary rocks, which include calcareous rocks, tactite and hornfels, with small amounts of argillite and quartzite. A monzonite intrusion into the sedimentary series is only weakly mineralized and its distribution appears to be unrelated to the distribution of tactite. Faulting has occurred both before and after mineralization. Sulphide-bearing beds are bottomed by a flat fault between an upper block of Paleozoic (?) limestone and a lower block of Precambrian granite. Leaching and enrichment of copper are confined to a thin layer at the top of the bedrock.
1.7	24.4	TURN RIGHT on Red Hill Road.
2.3	26.7	STOP 1. Entrance to Pima mine (Journeay, 31). Follow directions of flagmen. WATCH FOR ORE TRUCKS.

The Pima ore body was discovered by geophysical methods in 1950 (Heinrichs, Thurman, and Spaulding, 1954). Production began in December 1956 and the mine is presently operating at a rate of about 4,000 tons per day. The ore body lies beneath about 200 feet of alluvium, at the base of which is up to 25 feet of cemented conglomerate (fig. 42B). Ore occurs in metamorphosed carbonate rocks of probable Paleozoic age and in clastic rocks of questionable Cretaceous age. These rocks have been intruded by rhyolite, syenite and quartz-monzonite porphyry bodies. The main ore zone trends generally eastward with an average dip of 45° to the south. The zone averages about 200 feet in thickness, and has been developed laterally for 1,600 feet. Ore has been intersected in drill holes to a depth of 800 feet below the surface. High-grade ore is confined to a wedge of carbonate rock which carries pyrite, chalcopyrite, and minor bornite in the primary ore. Oxidation extends erratically to 50 feet below the top of bedrock.

Low-grade disseminated pyrite and chalcopyrite mineralization which makes open-pit mining operations feasible occurs in the clastics in the hanging wall of the main body and within a breccia along the footwall.

3.0	29.7	Leave entrance to Pima mine and return to intersection of Pima Mine Road and Twin Buttes Road.
5.6	35.3	TURN LEFT on Twin Buttes Road.
0.6	35.9	At 9:00, the north end of Mineral Hill composed of Cambrian Bolsa quartzite resting unconformably upon Precambrian granite. Klippen of Paleozoic limestone rest on Precambrian granite at 3:00.
0.7	36.6	At 9:00, Banner Mining Company's Mineral Hill mine (MacKenzie, 29). The Mineral Hill mine has been worked intermittently since 1882. Its present activity dates from 1951 and it has capacity to produce and treat 400 tons per day of high-grade copper ores.

Ore bodies occur at or near contacts of Tertiary (?) granite intrusives with Paleozoic limestone and quartzite. The deposits are pyrometasomatic type with contact zoning of the tactite and ore minerals (fig. 41C). The principal ore bodies are aligned along an east-west reverse fault which dips 35°-50° to the south. This fault has been offset by north-trending vertical tears. Three hundred feet below the surface, granite forms the footwall of the reverse fault. Ore bodies are localized where fault intersections occur adjacent to intrusives. A hydrated garnetite, locally called "clay-garnet," is the most favored host rock. Ore shoots are irregular in size and distribution and they generally dip at a flatter angle than the localizing reverse fault.

Principal copper mineralization is as chalcopyrite, with minor bornite and

chalcocite associated with local magnetite, pyrrhotite, molybdenite and scheelite.

0.1	36.7	STOP 2. At 10:00, Helmet Peak rises beyond East San Xavier Hill (fig. 42A). Helmet Peak is composed of Paleozoic limestone folded into a sharp anticlinal fold that plunges steeply to the south-southeast. It is bounded by faults and, at least in part, has been thrust to the south and east over Cretaceous (?) rocks. This is shown by klippen of limestone whose nature has been demonstrated by drilling south and east of Helmet Peak. The axis of the Helmet Peak fold has been swung out of alignment with the other folds of the area during a period of westward thrusting.

At 2:00, on West San Xavier Hill, Paleozoic limestone has been thrust over Precambrian granite. A klippe of limestone caps the northward-trending ridge and a syenite intrusion has come in along the thrust with accompanying metamorphism and copper mineralization. This is the northwest edge of the large San Xavier thrust which can be traced for three miles to the south where it is cut off by a left-lateral fault. To the north it disappears under alluvial cover at the edge of the San Xavier Indian Reservation.

0.6	37.3	At 9:00, San Xavier mine (Irvin, 30), among the earliest of Arizona's lead-zinc producers, was worked by Jesuits and Spaniards prior to 1875.

Ores are essentially of lead and zinc with values in copper and silver. They are typical pyrometasomatic deposits, although they cannot be related directly to any intrusive. Ore bodies occur in a wedge of Paleozoic limestone bounded by east-west reverse faults dipping at about 55° to the south. Where these reverse faults are intersected by vertical north- to east-trending tear faults, steeply dipping ore shoots are formed. Intersections of the reverse faults with flat thrusts have formed flat-lying ore shoots. Ore mineralization has replaced these brecciated zones within the limestones, particularly where earlier metamorphism had converted the limestone to a hedenbergite tactite. The principal ore minerals are galena, sphalerite and chalcopyrite; these replace the silicate minerals in the tactite. Ore bodies have been developed to a depth of 900 feet below the surface. Oxidation extends erratically to a depth of 400 feet.

Outcroppings adjacent to the road indicate the complexity of structure and show the typical lead-zinc gossan in the altered tactite.

0.5	37.8	STOP 3. A part of the Lower (?) Cretaceous section consisting of arkose and shale is exposed in the wash. To the east, up the wash, plug-like bodies of intrusive andesite and breccia are exposed cutting the sedimentary rocks.
0.1	37.9	TURN RIGHT on Dogtown Mines Road. You pass by dumps of many old lead-silver mines of the Olivette group of claims. Between 1886 and 1893 about $740,000 value in silver was removed from these claims from narrow fissure veins striking from north to east and dipping at about 40° to the east and north. Ores contained chalcopyrite, bornite, freibergite, sphalerite and galena along with pyrite and crustiform quartz. Ore shipments are reported to have carried 20 percent lead and 100 to 300 ounces of silver.
1.9	39.8	Road intersection, KEEP STRAIGHT AHEAD.
1.3	41.1	STOP 4 - LUNCH STOP. This is the site of the Paymaster mine, which lies along the western edge of the San Xavier thrust sheet. Brecciated intrusive andesite and Cretaceous (?) arkosic quartzite are thrust over Precambrian (?) granite along this fault zone. The breccias and thrust zone have been strongly silicified. Klippen of brecciated andesite and quartzite form low hills to the west of the thrust sheet. From a vantage point on the top of the small hill immediately northwest of the Paymaster mine, the San Xavier thrust can be traced by color differences and different topographic expression of the Precambrian (?) granite and the Cretaceous clastics and intrusives on either side of the fault.

The Paymaster mine is estimated to have produced about $220,000 in silver and lead from 1887 to 1908. The ore occurs in narrow fissures striking north-northeast and dipping steeply to the west. It is reported that at 250 feet in depth below the surface the veins dip to the east and follow down the andesite breccia-

granite contact. Two veins were developed: the Lead vein which contained principally galena; and the Iron vein which carried pyrite with a little chalcopyrite and tetrahedrite. The veins were gougey and had suffered from vigorous post-mineralization faulting in the general plane of the veins. Turn cars around in the cleared loop as directed by flagmen and return along the same road.

1.3	42.4	Dogtown Road intersection, KEEP TO RIGHT. You are passing by an andesite intrusive cut by many small veins.
0.5	42.9	Intersection. KEEP LEFT.
0.3	43.2	STOP 5. Breccia Hill. The origin of the silica-cemented quartzite breccia is unknown. It may be (1) of sedimentary origin; (2) as intrusive breccia-pipe structure; (3) a breccia related to the San Xavier thrust; (4) a klippe of a second overlying thrust sheet; or (5) a frontal phase adjacent to an intrusive plug.
1.3	44.5	At 9:00, on a little hill about 50 yards north of the road there is a thin limestone bed in the Cretaceous (?) clastics carrying abundant fossil algae and oysters.
0.1	44.6	TURN RIGHT on Twin Buttes Road.
0.2	44.7	STOP 6. Follow down wash to the east for 50 yards. The "Helmet fanglomerate," of possible middle Tertiary age, is separated from Tertiary tuff to the north by a fault -- or is it a sedimentary contact? The fanglomerate and tuff appear to be essentially post-mineral.
0.5	45.2	Amygdaloidal andesite porphyry flow or a shallow sill in "Helmet fanglomerate."
0.5	45.7	About 600 yards to the west of the road is an andesite dike cutting the "Helmet fanglomerate."
1.4	47.1	STRAIGHT AHEAD. Sahuarita Road turns off to left.
1.0	48.1	The road follows along a Tertiary biotite granite or quartz-monzonite stock which has metamorphosed the Paleozoic limestone and is generally associated with areas with copper mineralization. It appears to follow fractures related to an early stage of left-lateral and thrust faulting.
0.7	48.8	STRAIGHT AHEAD. McGee Road turns off to right.
0.4	49.2	Copper Glance mine at 11:00; Queen (Contention) mine at 5:00. During the nineties various gophering operations were carried on in the oxide copper showings in this area south of Twin Buttes. In 1905 the Twin Buttes Mining Company was formed and a railroad was built from Tucson. Remains of an old engine can still be seen just north of the Copper Glance mine. Operations were carried out until 1913 with the greatest attention concentrated on the Morgan group, a mile southwest of the Queen mine. Since that time, these properties have been profitably exploited by a series of leasors and companies. A total of over eight million dollars in copper has been removed from ore bodies in tactite. The Copper Glance, under management by the Banner Mining Company, is the only property active at present.
3.5	51.6	TURN RIGHT on Duval Mine Road.
2.0	53.6	STOP 7. Gate to Duval Sulphur Company's Esperanza mine (Schmitt and others, 33). Follow directions of flagmen. WATCH OUT FOR ORE TRUCKS. The Esperanza ore body was outlined by geological mapping of brecciation, alteration and leached capping in 1955, and has been prepared for operations to begin this spring. This property is more typical of a porphyry copper deposit than the Pima mine and Mission prospect. Ore occurs in an enriched blanket about 3,000 feet in diameter and 130 feet thick. The oxidized capping averages about 95 feet in thickness. The ore body lies in three types of rocks: A clastic series composed largely of greywacke, arkose, and conglomerate-breccia; an intrusive andesite; and a

quartz monzonite porphyry. There are two marked lineations -- southeast, which is followed by apophyses of the quartz monzonite intrusive, and a south-southwest direction of prominent faulting. A pre-ore east-west fault, dipping 25°-30° to the south marks the north boundary of the ore body.

Alteration of the host rocks is intense with the development of secondary quartz, biotite, clay minerals, sericite, chlorite and epidote. Primary sulphide minerals include chalcopyrite, pyrite and molybdenite, and secondary ore minerals include chalcocite developed in the enriched zone, and malachite, azurite, cuprite and turquoise in the oxide zone.

3.0	56.6	Exit, from Esperanza mine property. You may return to Tucson along the same route by which you came, or you may follow east on the Duval Mine Road to its intersection with U. S. Highway 89, turn left, and follow it into Tucson.
33.7	90.3	Back to Zero Point.