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THE DAYTON IRON DEPOSITS, LYON AND STOREY COUNTIES, NEVADA

By JOHN G. ROYLANCE, JR., Geologist,
Utah Construction & Mining Co.

ABSTRACT

The Dayton iron deposits are in a mountain pediment 22 miles southeast of Reno, Nev., between the villages of Dayton and Silver Springs, and 2 miles northwest of U. S. Highway 50. The principal deposit, called the main orebody, forms a low hill with about 100 feet of relief.

The iron ore deposits, essentially magnetite bodies with minor pyrite, have replaced folded metasedimentary rocks. Limestone beds in the metasedimentary rocks were more amenable to replacement than adjacent schists and hornfelses. The main orebody was formed in an asymmetrical anticline which is overturned to the east and has a core of granodiorite.

The folded sedimentary rocks are probably the oldest rocks in the district, and are considered to be Triassic or Early Jurassic. Predominantly metavolcanic rocks of probable Jurassic age crop out 1 1/2 miles southwest of the main orebody. In Late Jurassic (?) time these Mesozoic sedimentary and volcanic rocks were intruded by diorite. Subsequently, large scale folding occurred, followed by Sierran-type intrusions of granodiorite and quartz monzonite in the Cretaceous Period.

The Jurassic (?) diorite is pre-ore in age and the quartz monzonite at the main orebody is of post-ore age. The source rock for the mineralization is not known for certain, but is believed to be the granodiorite close to or in contact with the magnetite bodies.

INTRODUCTION

Although I do not know the origin of our conference theme (fig. 1), I can imagine it was first uttered as an expression of helplessness by an early prospector. Certainly, many of today's ore discoveries are made more by serendipity than by skillful pinpointing of a target. Our burro's * lucky master could attest to that!

Figure 1.

Magnetite, however, is in a class of mineral deposits that can easily be pinpointed by relatively simple geophysical techniques

*EDITOR'S NOTE: The Conference Burro was drawn by John G. Roylance, Jr.

(fig. 2). The extent of many of the Dayton iron deposits was first determined by ground magnetic surveys. In spite of the relative ease of discovering magnetite bodies, it is often difficult to interpret the geometry and origin of a deposit without considerable detailed geologic data. Figure 3 shows our prospector friend at the completion of his thorough geologic investigation.

Figure 2.

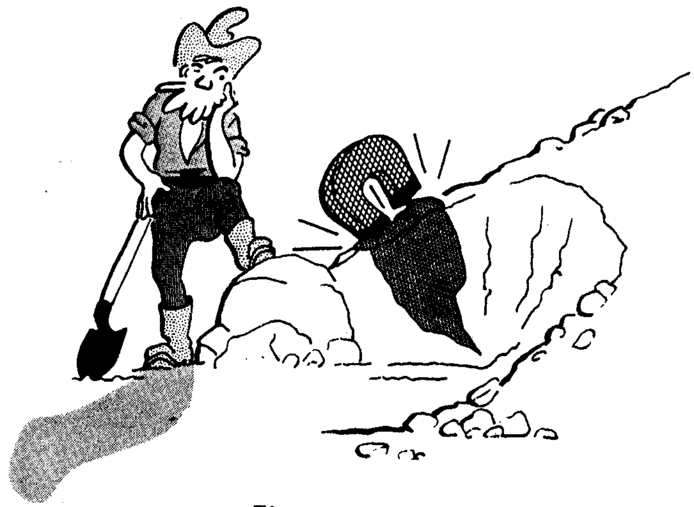


Figure 3.

The largest of the Dayton iron deposits, referred to as the main orebody, has been sufficiently investigated to allow me to describe it with some confidence. It will be the principal subject of this paper.

LOCATION

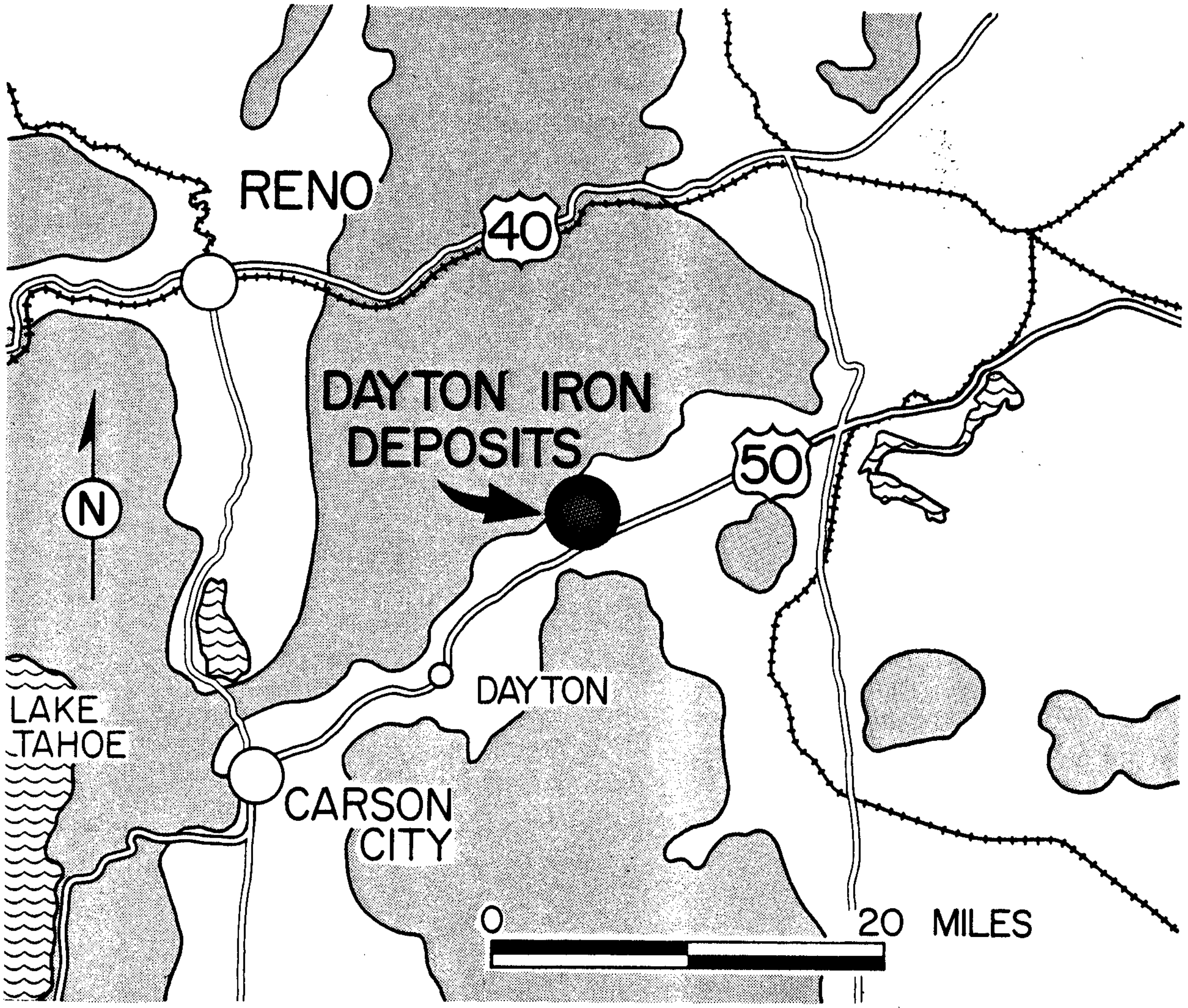
The Dayton iron deposits are in west-central Nevada (fig. 4), 22 miles southeast of Reno, and 12 miles northeast of their namesake, the village of Dayton. They lie 2 miles northwest of U. S. Highway 50, and 12 miles west of a siding on the Mina branch of the Southern Pacific railroad. No adverse grades exist between the railroad and the deposits.

The principal iron deposits crop out at an average elevation of 4,700 feet in a 3-mile-wide pediment at the southeast base of the Flowery Range (figs. 5 and 6).

HISTORY

The main iron deposit was claimed, partially explored, and patented in the period 1903 to 1908. The U. S. Bureau of Mines conducted additional exploration in 1942 by trenching, diamond drilling, mapping, and surveying with a dip needle. The dip needle survey completely delineated the areal extent of the main orebody.

Utah Construction and Mining Co. purchased the deposit in 1951 and investigated it during three periods between 1951 and 1961. By late 1961, 27,000 feet of diamond drilling and 36,000 feet of rotary drilling had been completed by the company. All of the rotary work was done by a self-propelled, tracked, Reich drill which generally utilized compressed air to raise the cuttings.



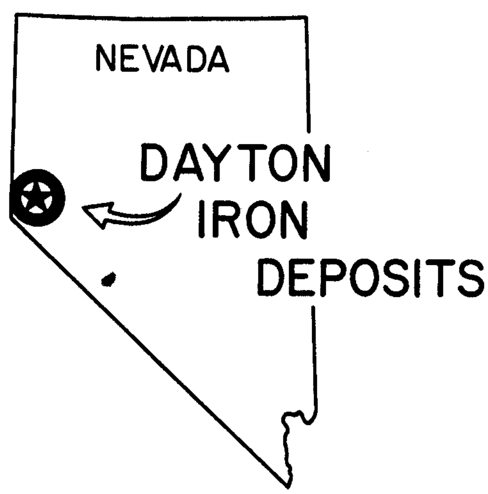


FIGURE 4. Location of the Dayton iron deposits. Mountainous areas are shaded.

FIGURE 5. View looking north at the main-orebody hill, in the center of the scene. The light-toned area at the base of the hill is a Pleistocene (?) deposit of calcareous tufa. The Flowery Range is in the background.

FIGURE 6. View looking southeast at the main-orebody hill, in the center of the picture. Beyond the main orebody, the pediment gives way to an alkaline dry lake.

DISTRICT GEOLOGY

The general geologic setting in shown in figure 7. The oldest rocks in the region are Triassic-Jurassic metasediments and metavolcanics (Msv), which are cut by Mesozoic diorite to quartz monzonite intrusives (Mi). Tertiary rocks, which include continental sediments and volcanics (Tsv), and Quaternary alluvium (Qal) together make up 95 percent of the exposed lithologies.

The district geology is detailed in figure 8. The oldest rocks probably are the metasediments (Ms), considered to be of Triassic age. These rocks originally were limestone, siltstone, and sandstone, but now are metamorphosed to marble, tactite, hornfels, granulite, gneiss, and schist. The metavolcanic rocks (Mv), are mostly mafic in composition, and probably are of Jurassic age; these rocks are metamorphosed to hornfels and granulite.

The oldest intrusive is diorite (dio); it cuts the metavolcanic rocks, and is thought to be Jurassic in age. In the southwest part of the district is granodiorite

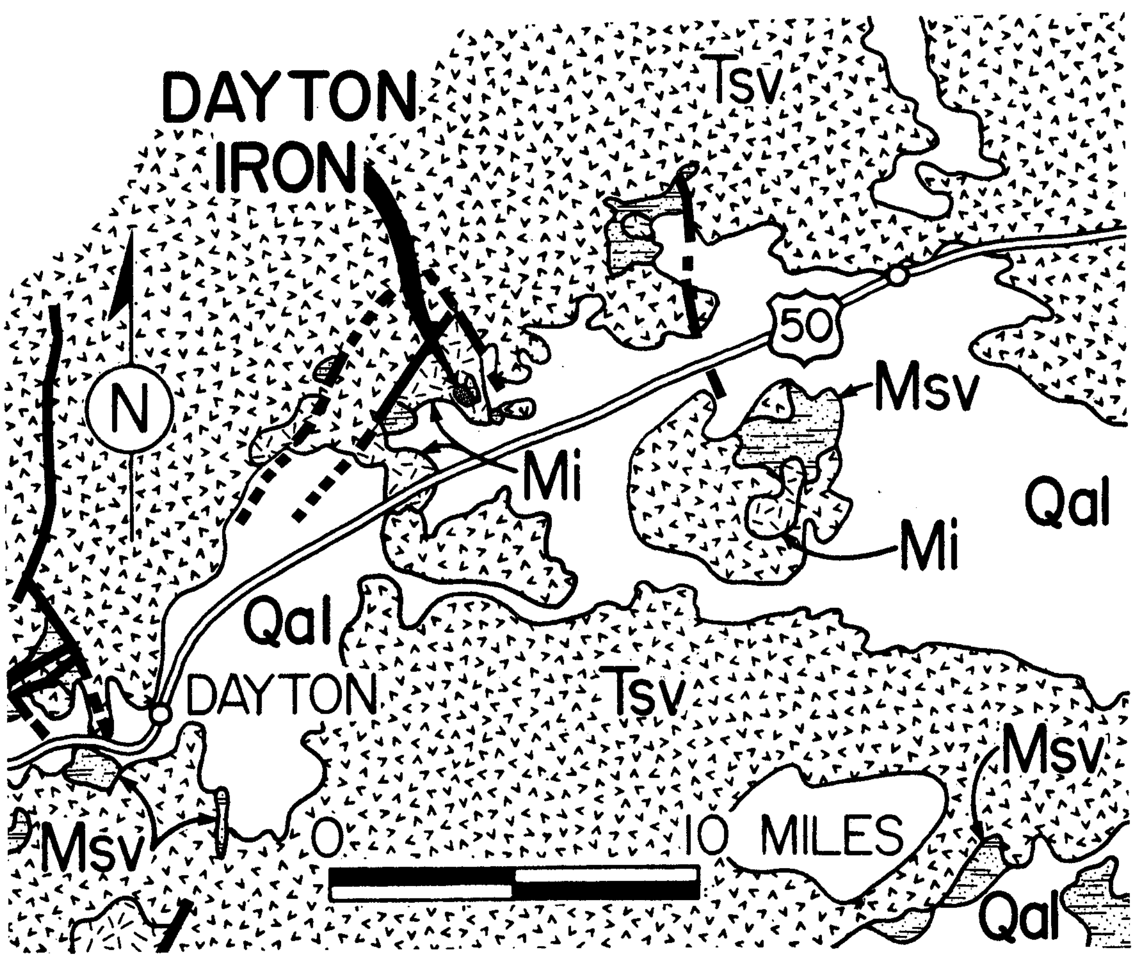


FIGURE 7. Geologic setting of the Dayton iron deposits. (Map symbols are explained in text.)

(gd), known to be younger than the diorite. Granodiorite also crops out at the main deposit, but the exposures are too small to appear on the map (fig. 8). Quartz monzonite (qm), probably Cretaceous in age and apparently younger than the granodiorite, occurs in the central part of the district.

The Tertiary volcanics (Tv) include a rhyolitic sequence overlain by andesitic rocks. A Tertiary andesite plug (Ti) occurs in the extreme southwest corner of the district. The calcareous tufa (Qt), in the central part of the district, may have developed at the shoreline of ancient Lake Lahontan during the Pleistocene. The blank areas represent Quaternary alluvium.

The largest exposure of iron oxide, in the central part of the district, and a smaller iron oxide occurrence, 1,000 feet northwest (labeled "1" on fig. 8), are connected at depth and together form the main Dayton iron deposit. Smaller, satellitic iron deposits are shown in the areas labeled "2" and "3" on figure 8. Area "2" contains several small magnetite bodies called the Iron Blossom deposits; these are quite close to the granodiorite contact, and are presumed to have been derived from the granodiorite magma.

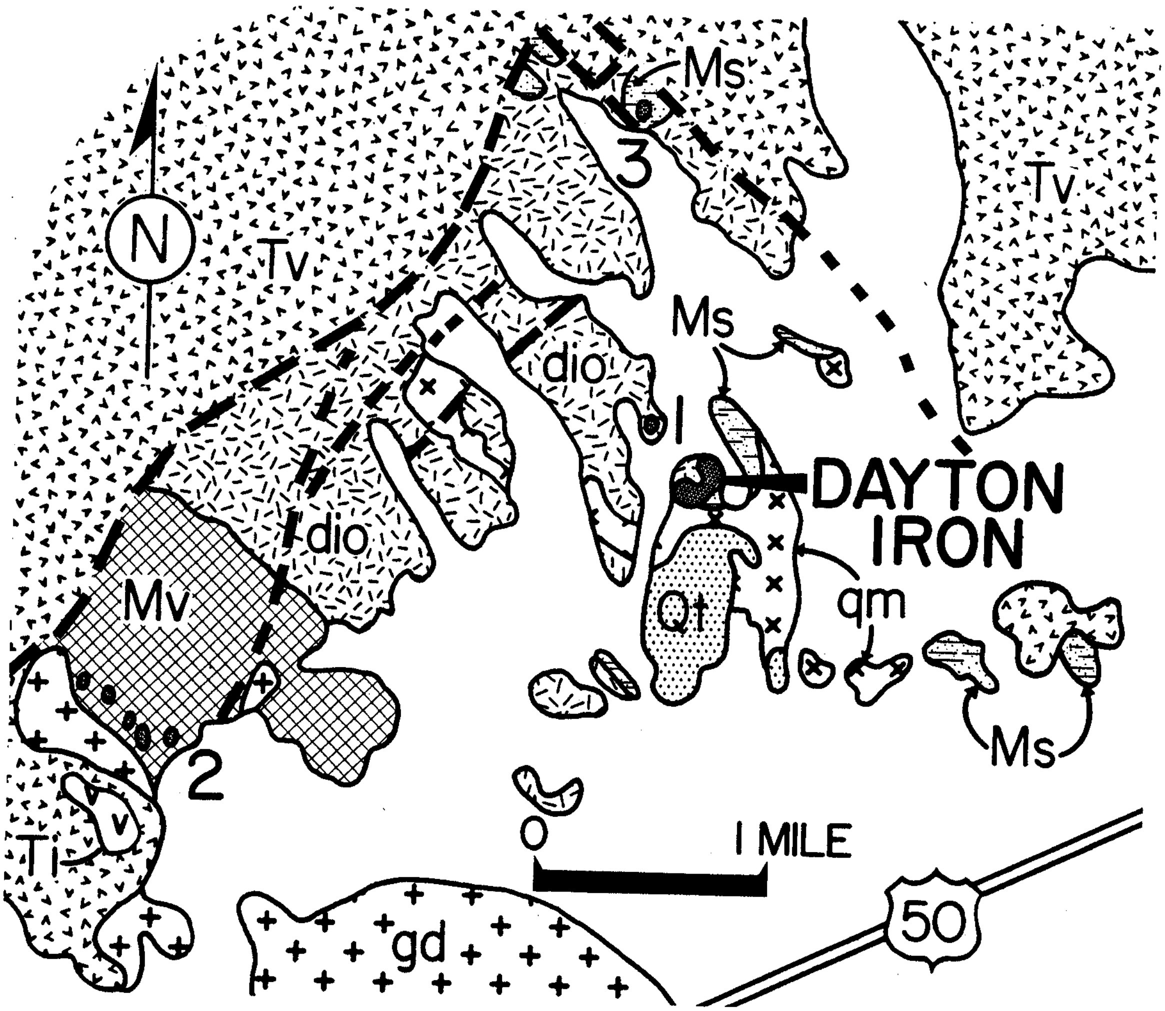


FIGURE 8. Geology in the vicinity of the Dayton iron deposits. (Map symbols are explained in text.)

THE MAIN OREBODY

Only the southern third of the total areal extent of the main orebody is exposed on the hill, shown in figures 9 and 10. Much of the northern half of the orebody is covered by 5 to 30 feet of alluvium. Figure 11, however, illustrates the bedrock geology as if all of the alluvium over the orebody were stripped away.

Rock units

The oldest units shown in figure 11 are the Triassic (?) metasedimentary rocks, divided into four units, named according to their pre-metamorphic compositions. From oldest to youngest, the four are lower meta-limestone, meta-siltstone, meta-sandstone, and upper meta-limestone. Deep burial, strong folding, and igneous intrusion have metamorphosed the former sediments to marble, tactite, hornfels, granulite, schist, and gneiss. The aggregate thickness of the metasedimentary rocks exceeds 1,200 feet.

The lower meta-limestone unit (lls) is composed mostly of marble with some tactite and is exposed mainly in the west central part of the deposit. Its greatest known thickness is 250 feet. Much of the unit's true extent is masked on this map and to a lesser degree in hand specimen due to replacement by magnetite. Northward and eastward the meta-limestone appears to change to a meta-siltstone facies.

FIGURE 9. View looking east at the west flank of the hill where the southern third of the main orebody is exposed. The dark area extending down from the high point is high-grade hematite-magnetite. The east-west cross section (fig. 13) passes through the adit to the right of the man.

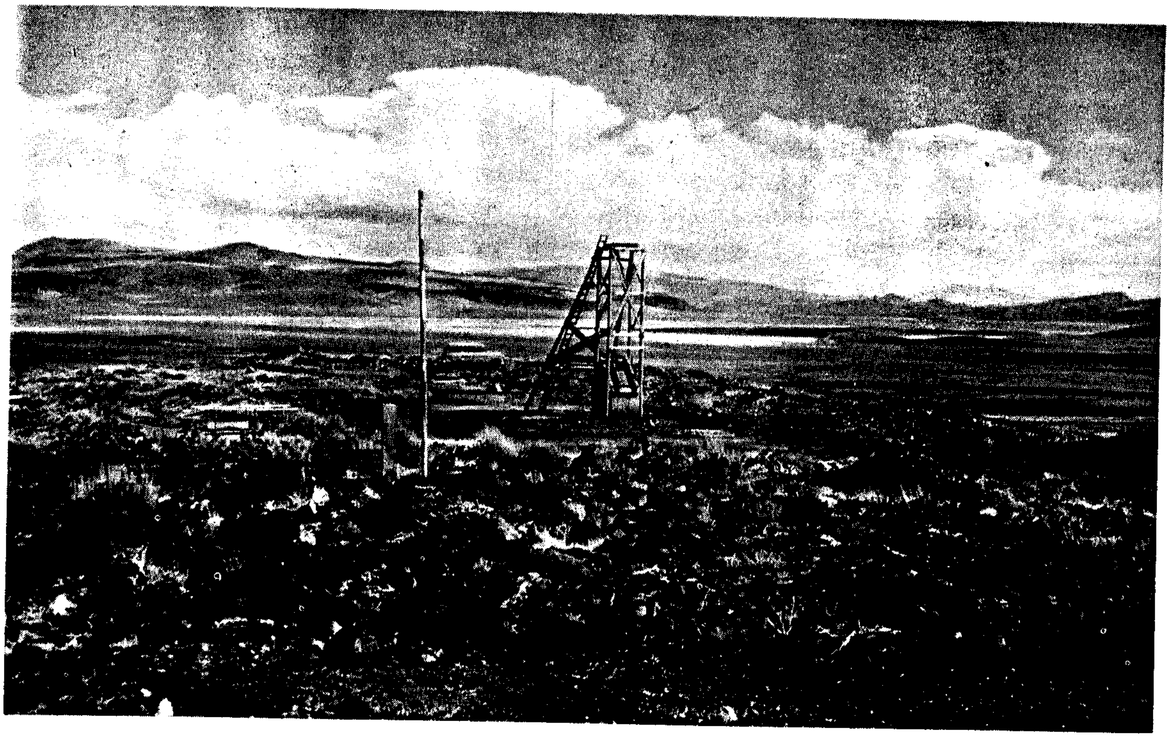


FIGURE 10. View looking southeast toward the dry lake bed from a position on top of the main-orebody hill. In the foreground is an outcrop of high grade magnetite/hematite ore. The vertical shaft shown is 160 feet deep, which is about the depth of the water table in that vicinity.

The meta-siltstone unit (sltst) is composed of chloritic and biotitic schist, dense hornfels, and biotitic granulite. It is partly equivalent in age to the lower meta-limestone, but most of the meta-siltstone definitely is younger. Some meta-limestone beds are included in this unit. The thickness of the meta-siltstone ranges from 100 to 250 feet.

Prior to metamorphism, the meta-sandstone unit (ss) was calcareous at its base and, in its upper portion, contained many interbeds of siltstone and limestone. The sediments are now metamorphosed to garnetiferous and diopsidic calc-silicate rocks, feldspathic hornfels, biotitic granulite, biotite schist, gneiss, and marble. This unit is probably 700 to 1,000 feet thick.

The upper meta-limestone unit (ls) is composed principally of marble with some garnet-epidote tactite, and it attains a minimum thickness of 200 feet.

Four types of intrusives occur in the main orebody area: diorite (dio); granodiorite (gd), not shown on the map because the exposures are very small; quartz monzonite (qm); and aplite/rhyolite (ap).

The diorite is the oldest intrusive rock, and was emplaced before late-Jurassic (?) orogeny had strongly deformed the Triassic (?) metasedimentary rocks. The intrusive is weakly foliated over broad areas and in numerous places it has been converted to a biotitic or chloritic schist. Thin sections show that the diorite

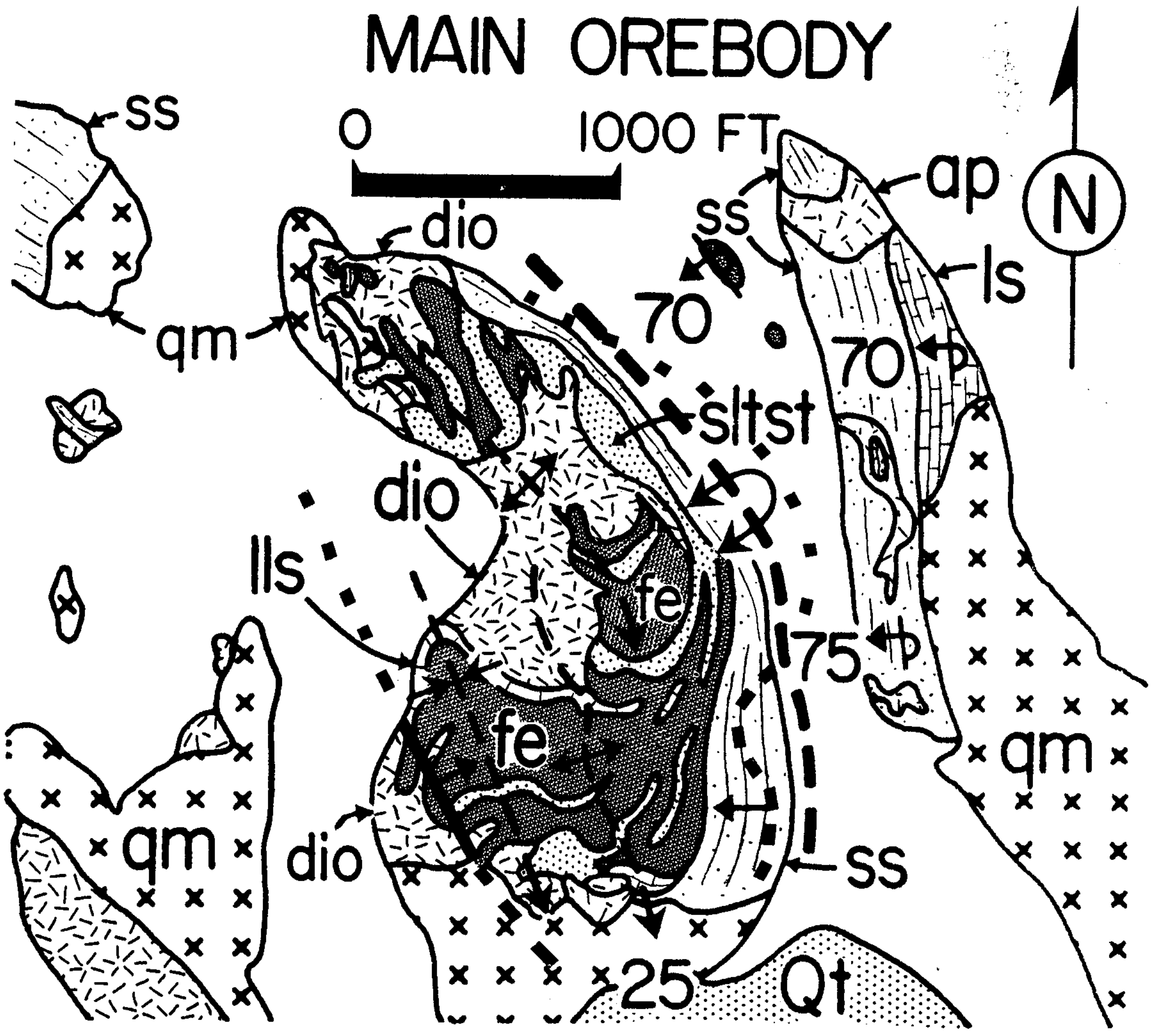


FIGURE 11. Bedrock geology of the main orebody. (Map symbols are explained in text.)

was intensely deformed after crystallization was complete and that it was later metasomatized, primarily by introduction of potassium. The diorite mostly cross-cuts the metasedimentary rocks but it also forms sills in many places.

The granodiorite is mainly in the core of the anticline, and thus is found primarily in underground workings and drill holes in the main orebody. This granodiorite, similar to that near the Iron Blossom magnetite deposits, is believed to have been the source of the magnetite in the main orebody. The rock in thin sections shows little deformation; the few deformational features observed are ascribed to late magmatic movements.

The quartz monzonite is apparently the youngest major intrusive. It probably is Cretaceous in age and is believed to be younger than the bulk of the magnetite in the Dayton district.

Dikes, sills, and irregular bodies of aplite and rhyolite occur throughout the map area. Most are too small to be shown in figure 11. The aplite/rhyolite bodies are of two ages with one group related to the granodiorite and one related to the quartz monzonite.

Structures

Figures 13-14 illustrate the structure and the pre-magnetite and post-magnetite lithology of the main orebody along the two cross sections shown on figure 12.

Basically, the structure of the metasedimentary rocks is that of an anticline overturned to the northeast and east. The subsidiary folds exposed at the surface in the south half of the main orebody plunge moderately south (fig. 11); but the overturned anticline itself does not plunge south. The folding of the metasediments probably occurred during at least two separate episodes of major tectonism between the Middle Jurassic and Late Cretaceous.

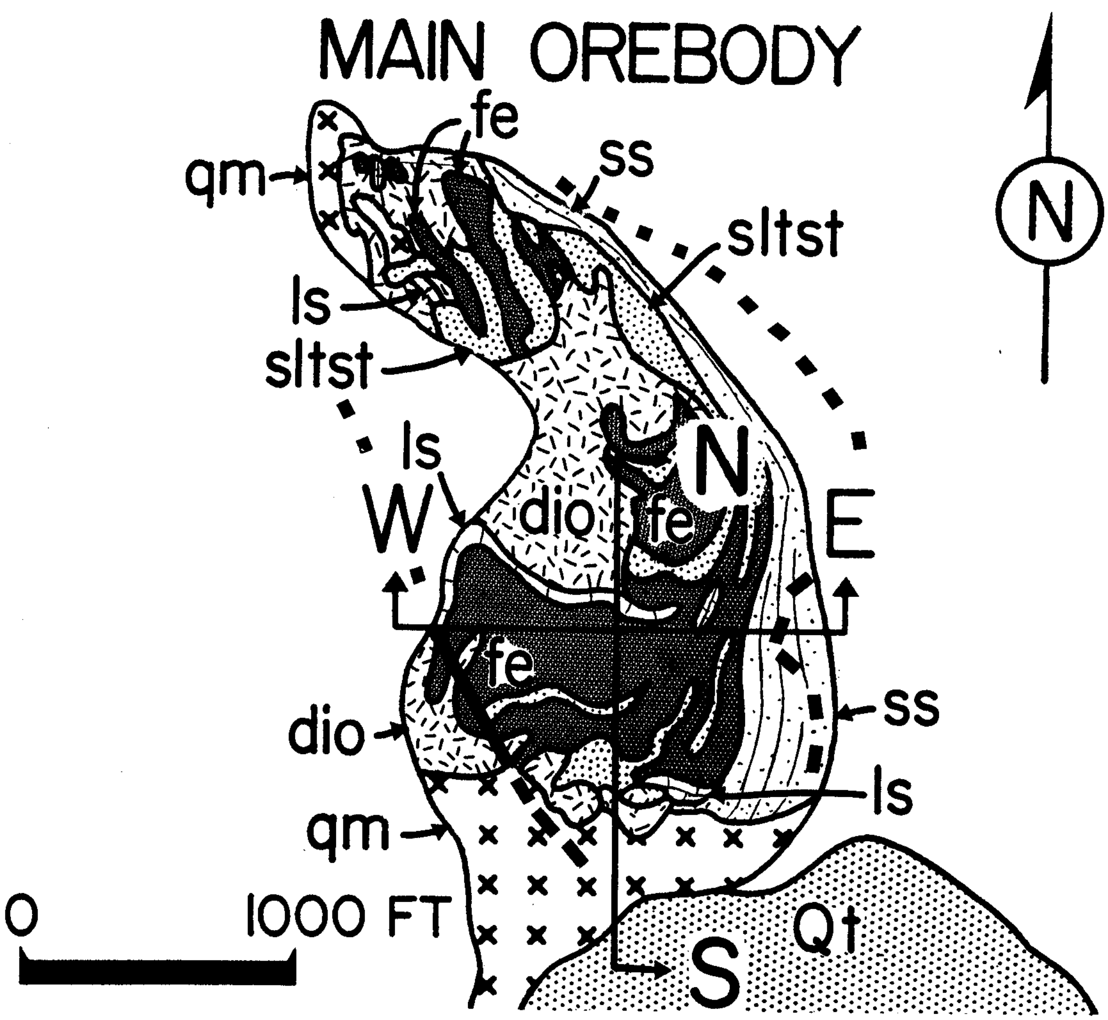
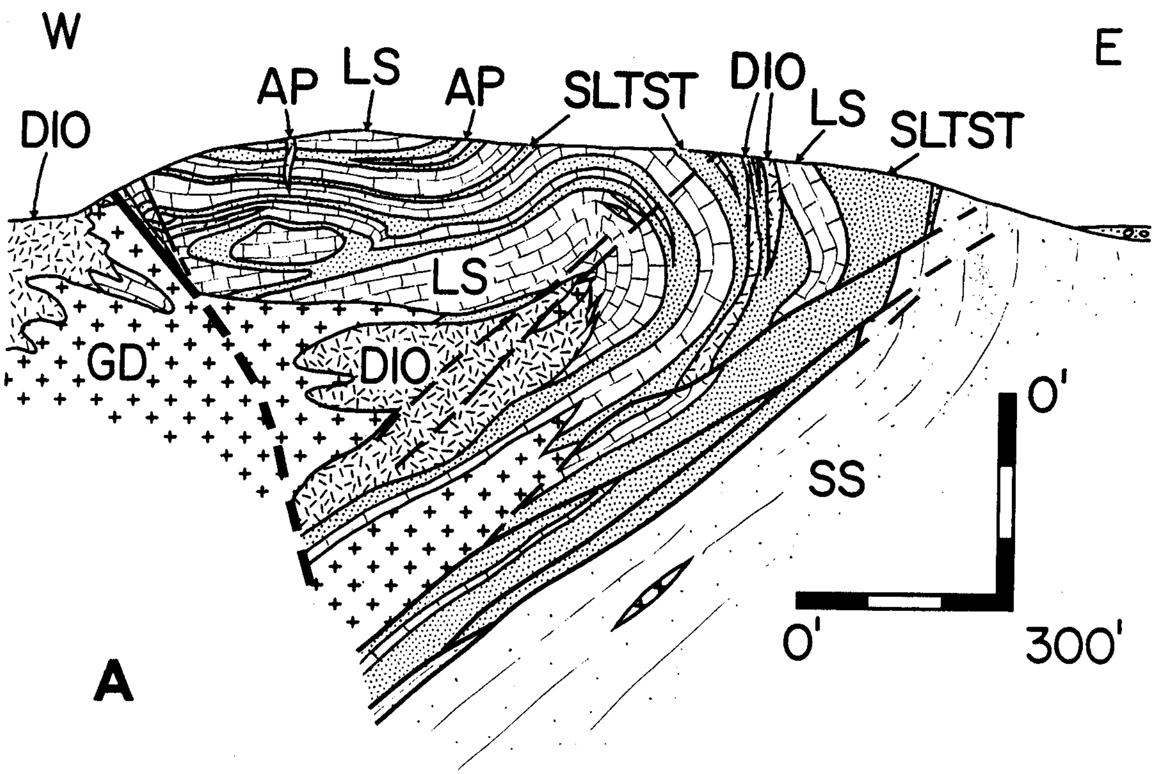
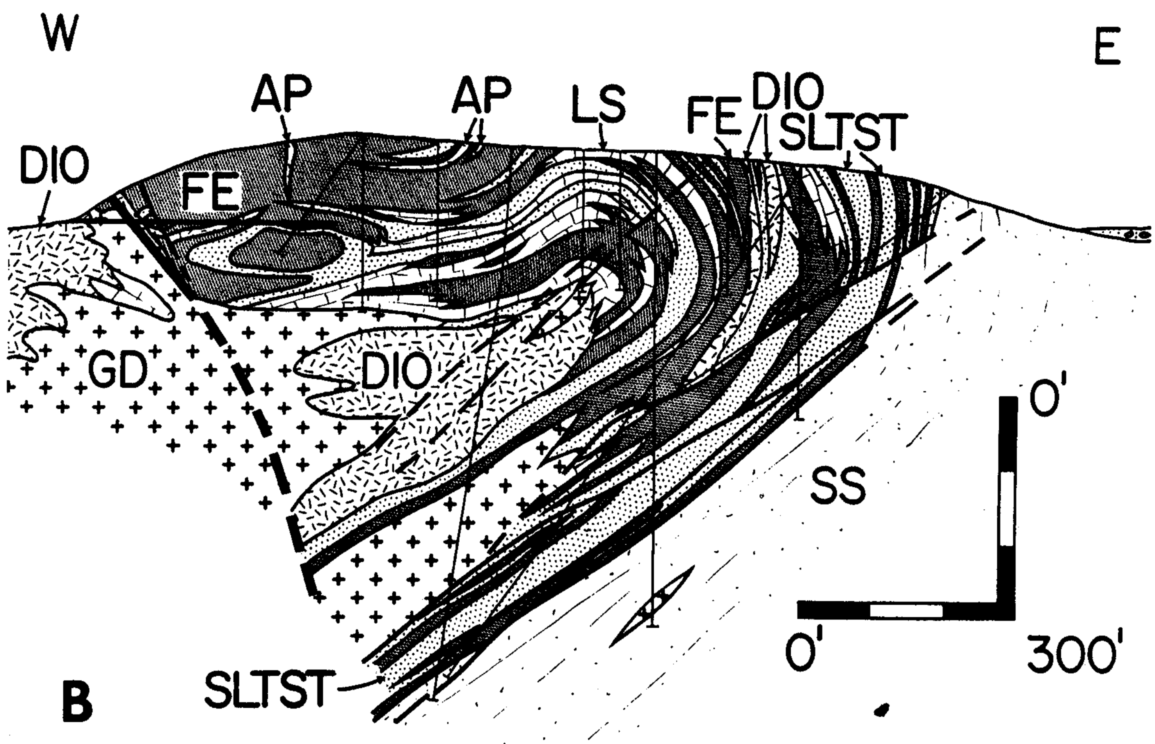


FIGURE 12. Location of W-E and N-S cross sections in relation to the bedrock geology of the main orebody.



A



B

FIGURE 13. Geology along W-E cross section shown in figure 12. (A) shows the pre-magnetite geology; (B) shows the present lithology and structures. Areas of magnetite and magnetite/hematite ore containing more than 35 percent iron are crosshatched and labeled FE. Drill holes are shown as thin lines.

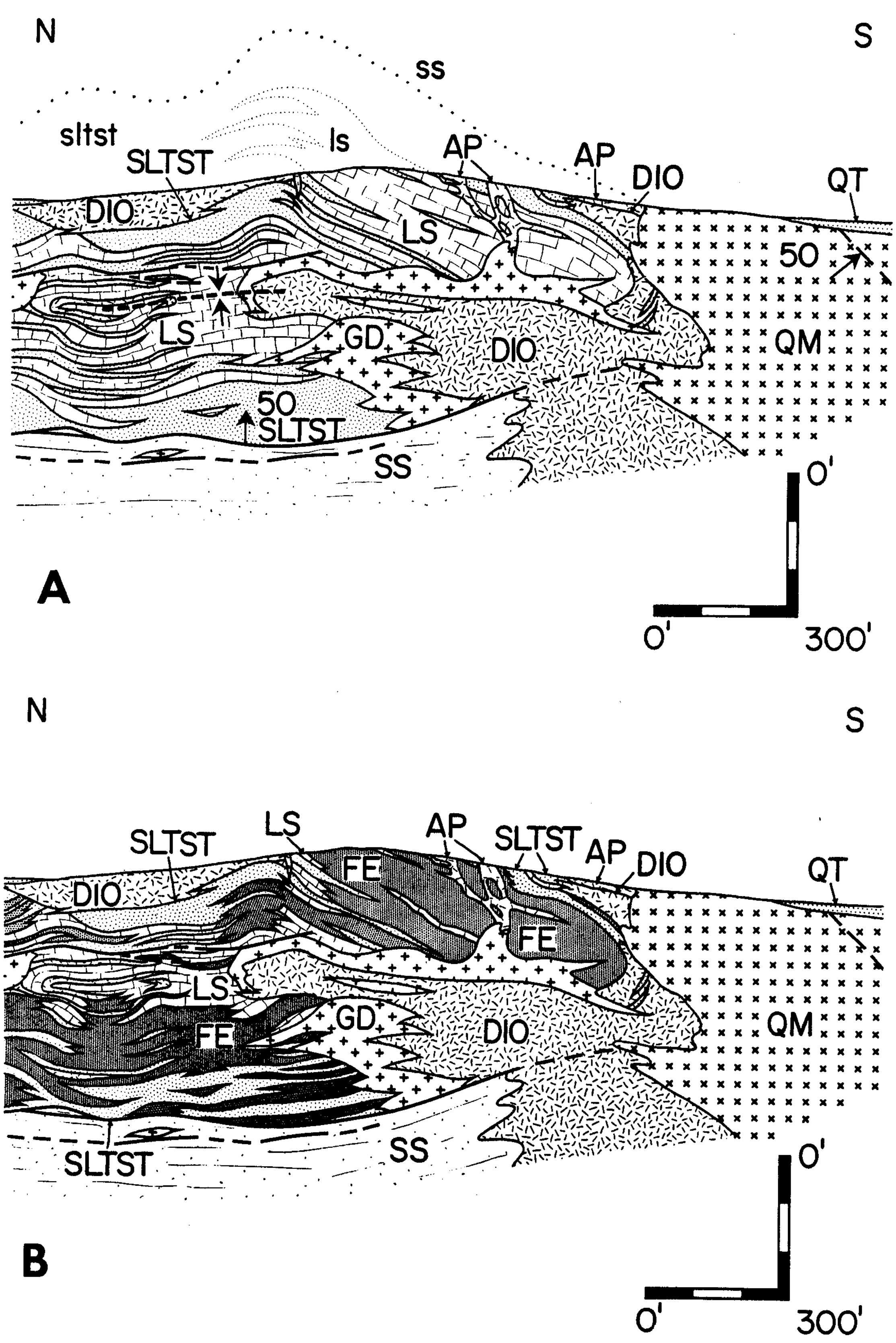


FIGURE 14. Geology along N-S cross section shown in figure 12. (A) shows the pre-magnetite geology; (B) shows the post-magnetite lithology and structures. Restored contacts are shown above the present ground surface. Ore containing more than 35 percent iron is shown by crosshatching.

A west-dipping fault at the east side of the main orebody is projected to the surface from drill hole intercepts. This fault, probably a thrust, follows inferred bedding along the west-dipping base of the magnetite/hematite orebody. An east-dipping fault at the west side of the main orebody may have displaced rocks as much as 200 feet. The latest movement was strike slip. Both faults exhibit post-magnetite movement, but both probably existed at the time of magnetite deposition and were influential in guiding the mineralizing fluids.

The Ore

The crosshatched pattern (fe) in figures 11, 13B, and 14B represents ore with a grade of 35 percent or more iron. Originally, the ore was composed of magnetite with a few percent pyrite. Now oxidation has affected the ore to a depth of about 100 feet, converting pyrite to limonite and partially altering the magnetite to hematite.

The magnetite is principally bedding-controlled. A comparison of figures 13A and B, and 14A and B, shows that the magnetite has replaced the meta-limestone in preference to other nearby rock types including the meta-sandstone unit. There also has been greater magnetite replacement along the lower, overturned limb of the anticline than along the upper limb.

Figure 15 is a ground magnetic contour map of the same area and at the same scale as the geologic map, figure 11. A comparison of the two figures shows how well the magnetic data delineate the areal extent of the main orebody.

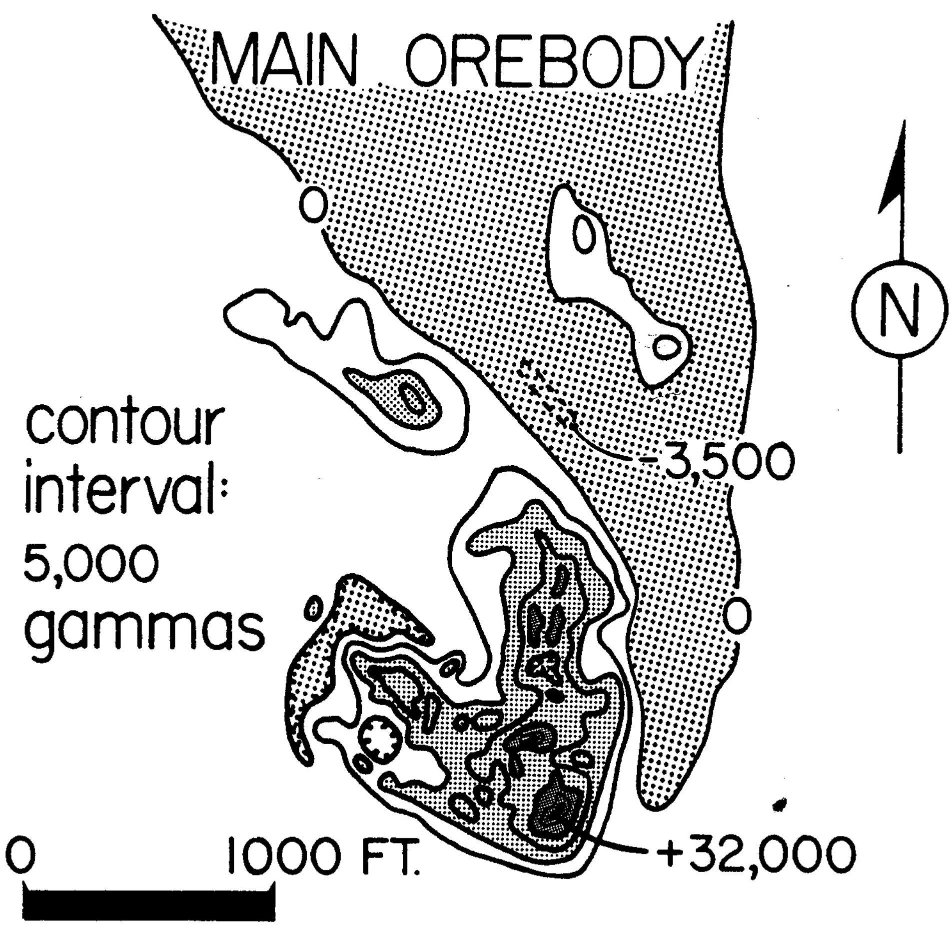


FIGURE 15. Ground magnetic contour map of the main orebody.

Oxidation

Oxidation can have a significant effect on the marketability of an iron ore deposit. Thorough oxidation and leaching can change an undesirable high-sulfur iron ore into a product that can be shipped directly to the blast furnaces without prior treatment.

Figure 16 illustrates the variable effects of oxidation on the Dayton main orebody along the W-E cross section (fig. 13). The white areas at the lower left of the figure (16A) represent intrusives without pyrite; the white area at the lower right of the cross section represents the meta-sandstone unit, which contains no magnetite and very little pyrite; the white area in the upper left is not adequately sampled to show the sulfur content. Above the water table the rocks with greater than 1 percent sulfur include sulfur in both gypsum and pyrite. Below the water table the sulfur is entirely in pyrite, the rock averaging 3.7 percent sulfur. The zone of less than 0.1 percent sulfur in the eastern two thirds of the section extends about 100 feet below the surface. The is the zone of oxidation and strong leaching.

On figure 16B the area shown as "unoxidized" contains no hematite; magnetite is the only iron oxide. No sulfides remain in the area labelled "thoroughly oxidized"; here much hematite was formed from magnetite and sulfur-bearing minerals are extremely rare. The transitional zone has partial oxidation of pyrite and magnetite.

Presently the water table is below the oxidized zone and the system is not in equilibrium. However, the narrowness of the transition zone in the eastern two thirds of the hill indicates that an ancient water table and local topography were stable for an extensive period of time, until the water table dropped in the recent past. In the western third of the hill, the water table has been receding too rapidly for oxidation to keep pace with it. This may be due to relatively recent erosion that removed a mass of land from the west side of the existing hill.

Origin of the Magnetite

The magnetite is believed to have been derived from the granodiorite intrusives and to have differentially replaced the meta-limestones of the metasedimentary sequence.

The magnetite of the main orebody appears to have been deposited after both the metasedimentary rocks and the intruded diorite had been folded into the overturned anticline. This theory is partly substantiated by the fact that, in the meta-siltstone unit, magnetite deposition was more intense in hornfels strongly sheared along bedding planes than in unsheared hornfels. Presumably the great amount of bedding plane shearing in the meta-siltstone unit occurred as beds slipped by one another during folding. The sheared zones channelled the iron-rich fluids.

Quartz monzonite occurs near the main iron deposit but is not associated with any other significant iron deposits in the district. Indication that the quartz monzonite formed later than the magnetite is provided by a small quartz monzonite dike which cuts sharply through magnetite on the south slope of the main-orebody hill.

Diorite is regionally metamorphosed and is evidently much older than the magnetite, which does not appear to be metamorphosed at all. A considerable difference in the ages of the diorite and the magnetite is also indicated by the observation that a little magnetite, and rhyolite believed to have formed contemporaneously with the magnetite, replace schistose zones in the diorite.

Granodiorite is more intimately associated with the main orebody than quartz monzonite and appears to be closer in age to the magnetite than is the diorite. Furthermore, granodiorite occurs close to almost every magnetite deposit in the Dayton district. Therefore, granodiorite is considered to have been the source for most of the magnetite.

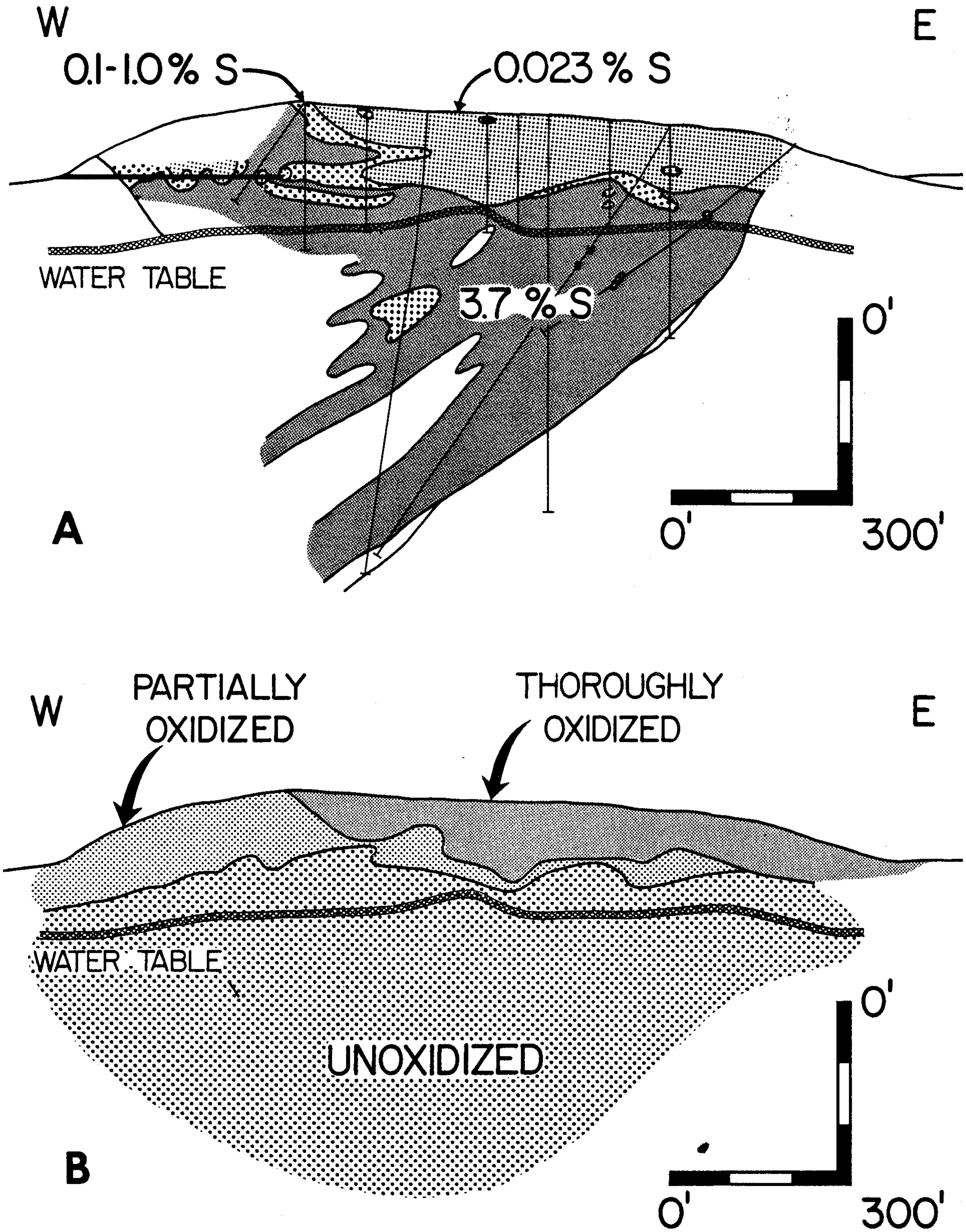


FIGURE 16. Effects of oxidation on the main orebody. (A) shows the sulfur content (weight percent) of the ore zone; (B) shows the degree of oxidation.

GEOLOGIC HISTORY

Although alternate interpretations of the geologic data cannot be denied, the following geologic history of the Dayton main orebody area fits all the observed local and regional geologic information. The sequence of geologic events is illustrated in five successive diagrams (fig. 17).

In Late Jurassic (?) time (fig. 17A) sedimentary rocks were deeply buried, intruded and metamorphosed by diorite, and strongly folded. The northwest-trending black line on the figure is the trace of the axial plane of the overturned anticline that was formed; the dashed, southeast extension of the fold axis represents the sedimentary section which was probably cut out by the pre-folding diorite intrusive. The gray dashed line represents the position of a postulated fault, which, if present, is thought to have originated later, in the Cretaceous period.

In Middle Cretaceous (?) time (fig. 17B), right-lateral movement along this postulated fault could have drag-folded the overturned anticline, bowing it convexly eastward and forming two small, south-plunging folds in the upper limb of the anticline.

In Late Cretaceous (?) time (fig. 17C), granodiorite (GD) worked its way up the fault zone and into the core of the overturned anticline. Iron-rich fluids (shown by large arrows) concentrated in the cooling magma and were ejected, along with rhyolitic magma, into the surrounding metasediments.

Following cooling of the granodiorite magma and deposition of the magnetite (FE), renewed movement apparently occurred on the postulated fault zone (fig. 17D). The re-opened fault zone provided a channel along which the quartz monzonite (QM) was intruded in latest Cretaceous time (fig. 17E).

Following intrusion of the quartz monzonite, the Dayton district was subjected to uplift, erosion, Tertiary volcanism, block faulting, and further erosion which is continuing today. Before erosion proceeds too far, however, we expect that the main Dayton iron deposit will be an open pit mine and an important producer of iron ore.

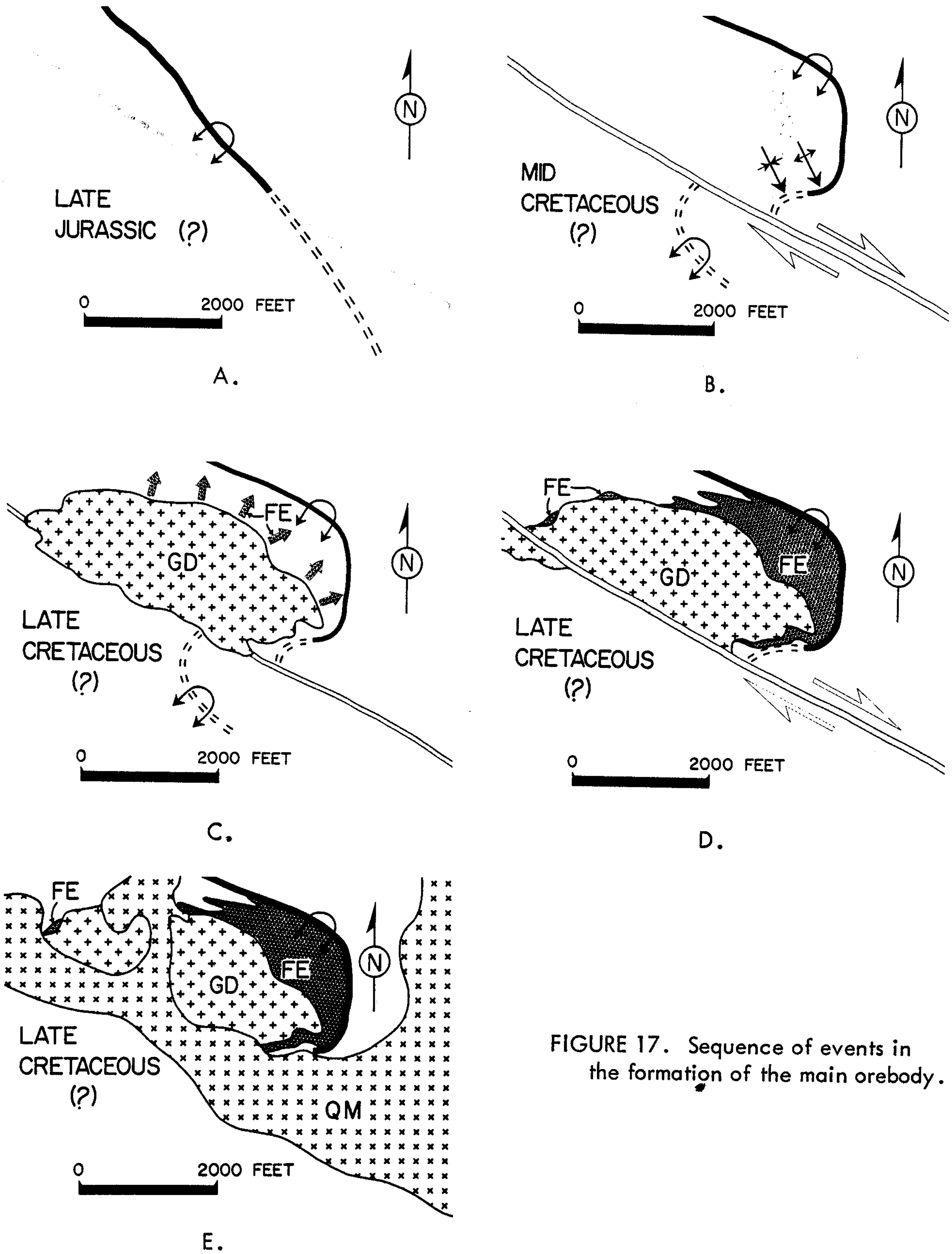


FIGURE 17. Sequence of events in the formation of the main orebody.