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GEOLOGY AND ORE DEPOSITS OF THE GLOBE QUADRANGLE

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INTRODUCTION

The Globe 7½-minute quadrangle is the northeast quarter of the original Globe 15-minute quadrangle as mapped by the U. S. Geological Survey in 1901. It includes approximately the eastern half of the Globe-Miami mining district. The geology of the Globe 15-minute quadrangle was mapped by F. L. Ransome (1903 and 1904) in 1901 and 1902 at which time the Old Dominion mine was attracting considerable attention as a producer of copper. The geology of the Globe 7½-minute quadrangle was remapped during various periods from 1945 to 1948 (Peterson, 1954) in connection with a comprehensive study of the Globe-Miami district by the Geological Survey.

The new quadrangle map includes portions of three local topographic provinces: the lower foothills of the Apache Peaks which lie to the northeast, the lower foothills of the Pinal Mountains to the southwest, and the deeply alluviated Globe Valley between the two ranges.

ROCK FORMATIONS

The rock formations of the Globe quadrangle are typical of the region and have been adequately described in many published reports (Ransome, 1903, 1904, 1919, 1923; Darton, 1925; Short and others, 1943; Peterson and others, 1951; Peterson, 1954).

The oldest formation in the area is the Pinal schist, which forms the basement in all but the extreme northern part of the quadrangle where Ruin granite, part of an extensive mass intrusive into the schist, underlies the younger rocks. The Pinal schist and Ruin granite are both of early Precambrian age.

A profound unconformity separates the Pinal schist from the younger Precambrian Apache group. All members of the Apache group are present, but owing to the intricate faulting in this area, no complete sections of the group are known. The approximate thicknesses of the various members measured in sections adjacent to the Old Dominion vein are as follows: Scanlan conglomerate and Pioneer formation, 275 feet; Barnes conglomerate, 20 feet; Dripping Spring quartzite, 425 feet; Mescal limestone, 200 feet; basalt (incomplete section), 50 feet.

An irregular erosion surface of considerable relief separates the Apache group from the Troy quartzite, remnants of which have a maximum thickness of about 700 feet. The Troy quartzite has long been regarded as Cambrian; but on the basis of recent studies in adjacent areas, it is now believed to be upper Precambrian in age.

The Paleozoic formations, Martin limestone, Escabrosa limestone, and Naco limestone, of Devonian, Mississippian, and Pennsylvanian ages respectively, occur in a few scattered outcrops of downfaulted blocks mainly in the hanging wall of the Old Dominion vein.

Next in age are several types of intrusive igneous rocks that probably were emplaced in late Cretaceous or early Tertiary time. These include the Lost Gulch quartz monzonite and granite porphyry, both confined to the Copper Cities subarea at the western edge of the quadrangle, diabase, and many small bodies of diorite porphyry. In the Globe Hills area east of Pinal Creek (fig. 1), the age relations of the diabase are not as clear as in the Copper Cities area, but the Paleozoic limestones seem to be displaced by faults formed during the emplacement of the diabase; however, some of the diabase here could be of Precambrian age.

As a result of extensive faulting and erosion that occurred during and after the igneous intrusions, the Tertiary (?) and Quaternary formations were laid down unconformably on an irregular surface that was a complex mosaic of Precambrian and Paleozoic rocks. The oldest of these formations, the Whitetail conglomerate, consists of locally derived erosional debris that accumulated in channels and valleys of the old land surface. In the Globe quadrangle it is commonly absent or too thin to be recognized.

A sheet of dacitic tuff, ejected from vents to the west of the Globe-Miami district, overlies the Whitetail conglomerate and at one time blanketed the entire quadrangle. A remnant of the sheet penetrated by a drill hole near the west edge of Globe is more than 1,000 feet in thickness.

The dacite sheet had been largely stripped off by erosion before deposition of the Gila conglomerate began. The principal mass of Gila conglomerate fills a deep structural basin between the towns of Miami and Globe, and extends northward along Miami Wash and Pinal Creek. The mass was deposited as two, probably interfingering, systems of alluvial fans, one of which is composed of debris washed down from the Apache Peaks to the north, the other of coarse unsorted talus from the Pinal Mountains to the south. The fans of the two systems differ greatly in composition and character, particularly in their properties of storing and transmitting groundwater.

STRUCTURE

The Globe quadrangle embraces parts of three major structural blocks which will be referred to as (1) the Globe Hills block, (2) the Inspiration block, and (3) the Globe Valley block.

The Globe Hills block includes the northeastern half of the quadrangle. Its southwestern boundary is approximately along the course of Pinal Creek (fig. 1). The outcrops in this area of the block are predominantly of diabase, which forms a complex of sills and steep dikes intruded into the sedimentary formations. In detail, the sedimentary strata are broken and displaced by a maze of small faults most of which probably formed during the emplacement of the diabase magma. It is noteworthy, however, that throughout the Globe-Miami district, the deeply-rooted structures, those that controlled the course of igneous intrusions and those that became channels for mineralizing solutions, strike northeastward roughly parallel to the Precambrian grain of the region.

The Inspiration block includes all the western part of the Globe-Miami district, and only a narrow segment of the block extends across the western boundary of the Globe quadrangle. The early Precambrian schist and Ruin granite and the younger granitic intrusive rocks are the predominant outcrops in this block. These rocks contain all the large disseminated copper deposits of the district.

The Globe Valley block is a graben inset between the Globe Hills block and the Inspiration block. It is roughly triangular, bounded on the west and south sides by the Miami fault and on the northeast side by a broad zone of westward-dipping step faults whose general trend

is along the course of Pinal Creek. In the vicinity of Miami the throw of the Miami fault is at least 1,500 feet; it decreases northeastward, and probably increases toward the southwest. The total throw on the fault zone along Pinal Creek is only a few hundred feet; thus the block has been depressed relative to the adjacent blocks, and tilted toward the southwest. The outcrops within the bounds of the Globe Valley block are almost entirely of Gila conglomerate, which near the center of the block is known to exceed 4,000 feet in thickness.

ORE DEPOSITS

History of mining

The early history of Globe is concerned mainly with the development and exploitation of the ore deposits related to the Old Dominion vein system. The Old Dominion vein was discovered in 1875; but owing to the remoteness of the region, there was little interest in copper mining during the ensuing seven years. In the meantime, the rich silver deposits of Richmond Basin had been discovered, and many small silver-gold deposits were being worked in the area north of Globe. The silver and gold were found concentrated in the gossans of pyritic copper veins, and the values usually gave out at depths of less than 50 feet below the outcrops.

Exploitation of the Old Dominion vein for copper began in 1882; but, until completion of the railroad into Globe in 1898, only the richest oxidized ore could be mined and treated at a profit. Coke for smelting the ore was brought from England and hauled by wagon from Willcox to Globe, a distance of 120 miles. During the next thirty years various segments of the Old Dominion vein system were being developed and mined by the Old Dominion Co., the Arizona Commercial Mining Co, and the Iron Cap Copper Co.

At the beginning of 1931, the Old Dominion Co. was the only company still operating in the Globe area. The price of copper had fallen to less than 10 cents a pound. The known ore reserves were nearly depleted, and the 26th level of the mine had been developed with discouraging results. Rather than continue to operate at a loss, the mine was permanently closed down in October 1931 after 50 years of almost continuous operation. From 1882 to 1931, the mines along the Old Dominion vein system produced metals, mainly copper, valued at about $161 million.

Description of the deposit

The Old Dominion vein system has been developed for a strike length of about 3 miles, and was highly productive for at least 2½ miles. Its general strike is east-northeast, its dip ranges from 40° SE to vertical. From the main shaft near the north edge of Globe, the vein crops out for about 8,000 feet northeastward to a point at which it is cut by the Budget fault, which strikes about due north and dips westward.

Northeast of the Budget fault, the upper part of the vein fault has been shifted several hundred feet to the northwest by the Black Hawk fault, which strikes about parallel to the Old Dominion vein but dips 30°-40° NW. The lower segment of the vein fault was well mineralized up to its intersection with the footwall of the Black Hawk fault, and contained extensive ore bodies that were developed and stoped in the Iron Cap mine. In contrast, the upper offset segment, which is commonly referred to as the North vein, was but feebly mineralized and contained very little minable ore. This relationship clearly indicates that the displacement of the vein fault occurred before mineralization.

Toward the northeast, near the east boundary of the quadrangle, the Old Dominion vein becomes obscure and is poorly mineralized; whereas, the contiguous segment of the Black Hawk fault is strongly mineralized and is here known as the Great Eastern vein. The Great Eastern vein was developed in the Superior and Boston mine, and produced about $4.3 million in copper, silver, and gold.

Southeast of the Old Dominion main shaft the vein does not crop out, but has been developed for a strike length of about 4,600 feet beneath a cover of postmineral formations. The vein did at one time crop out on an old erosion surface which was later buried beneath the dacite sheet and Whitetail conglomerate. After the dacite eruption, a plate of early Precambrian quartz diorite was thrust over the dacite from the south or southwest. Remnants of this plate are in turn overlain by Gila conglomerate. The old erosion surface slopes toward the southwest, and is intersected by the 24th level of the mine about 4,400 feet southwest of the main shaft.

The Old Dominion vein fault has a long and complex history. The fault formed before the intrusion of the diabase, and the latest movement occurred after the eruption of the dacite. The vertical separation of key horizons in opposite walls of the vein ranges from less than 100 feet in the northeastern part of the Iron Cap mine to about 650 feet in the southwestern part of the Old Dominion mine; but because of movements caused by emplacement of diabase sills, these figures are not necessarily a true measure of the throw.

The volume of introduced vein matter seems clearly related to the types of rock traversed by the vein fault. Where Paleozoic limestone occurs in one wall, the fault is generally well mineralized, and replacement progressed outward from the fault along certain susceptible beds, forming large bodies of rich ore. These limestones were near the surface, and the ore was completely oxidized. Much of it may have been a direct replacement of limestone by supergene copper carbonates, silicates, and oxides. In all other places, the physical characteristics of the wall rocks was the controlling factor of the width and permeability of the fault zone. For example, those parts of the vein fault having brittle quartzite in one or both walls yielded wide zones of open breccia that were readily permeated and replaced by the mineralizing solutions; whereas, those parts having diabase in both walls yielded narrow, relatively impermeable and hence poorly mineralized zones.

The principal hypogene minerals are quartz, pyrite, chalcopyrite, bornite, and specular hematite. Sphalerite and galena occur locally in small amounts, and a little tetrahedrite and enargite have been reported. The character of the vein differed greatly from place to place, ranging from that of an irregular fissure lode to massive bodies of replaced breccia with sharp regular walls. Unfortunately, however, detailed descriptions of the mined-out ore bodies are generally lacking.

Supergene alteration

The Old Dominion vein is not typically capped by the usual leached zone, and rich oxidized ore commonly cropped out. Generally this ore was deep brown owing to the abundance of limonite, earthy hematite, and specular hematite; and although streaked by irregular veinlets of malachite and chrysocolla, most of the copper apparently

was present as cuprite.

According to Ransome (1903, p. 144), chalcocite was first noted on the 5th level of the Old Dominion mine, or about 350 feet below the surface; but oxidized ore prevailed down to the 10th level, or to a depth of 600 to 700 feet. The change to enriched chalcocite ore was between the 10th and 11th levels. However, as the mine was developed toward the southwest, these zones were found at progressively deeper levels conforming with the slope of the old erosion surface underlying the dacite sheet, thus indicating that much of the oxidation and enrichment took place before the dacite eruption.

The records concerning the lower limits of the chalcocite zone are meager. In the vicinity of the Old Dominion main shaft, chalcocite ore extended down to the 16th level or about 1,200 feet below the surface. Apparently the bottom of the zone is very irregular as is common in arid regions with a deep water table.

Other copper deposits

Other vein deposits in the Globe Hills area that are similar to the Old Dominion and have yielded some copper ore include the Big Johnnie, New Dominion, Buffalo, Maggie, Josh Billings, Buckeye-Black Oxide, and Stonewall.

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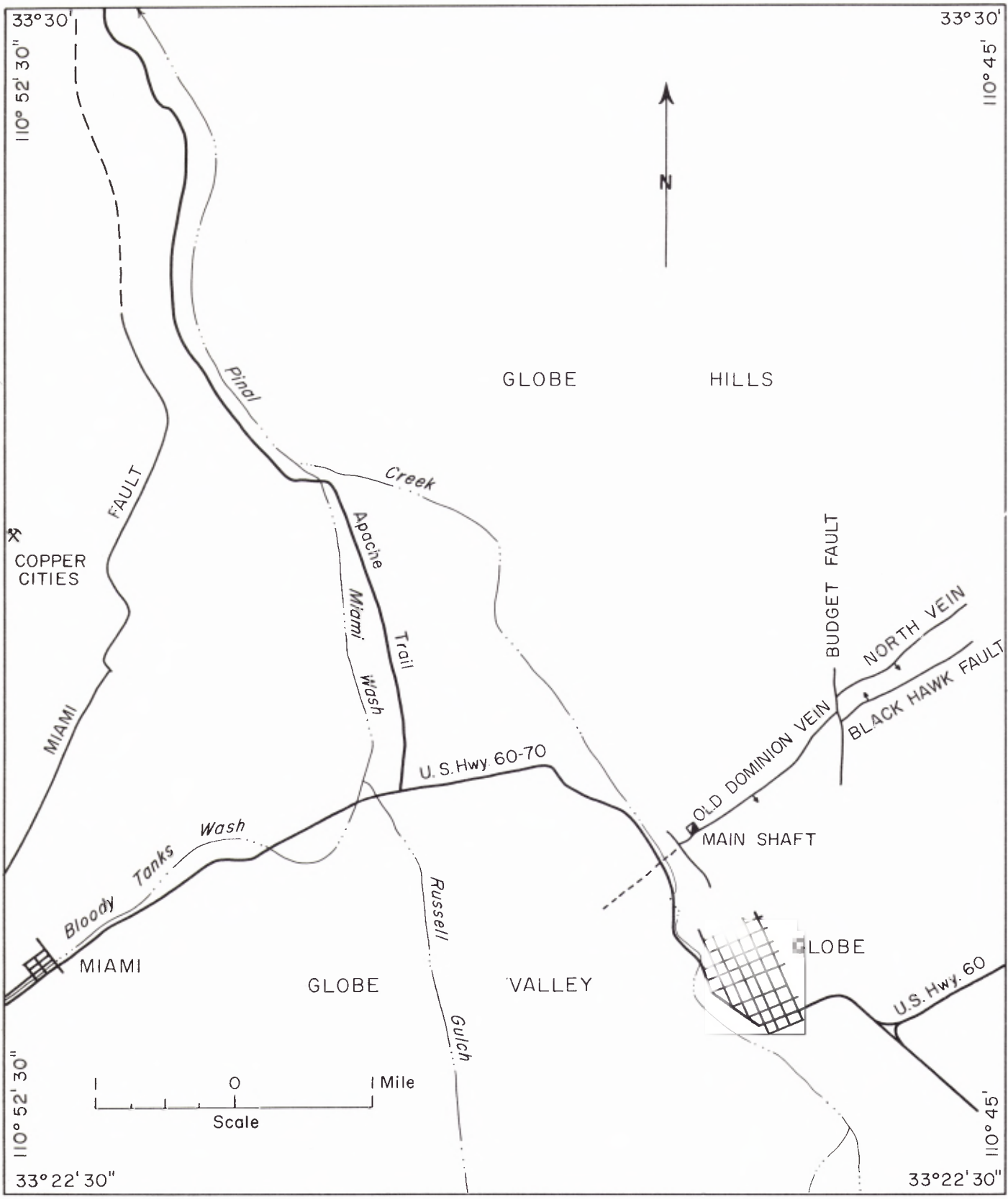

Figure 1. Index Map of Globe 7½-Minute Quadrangle