EFFECTS OF DIKES AND DISPLACEMENT MOVEMENTS ON SEDIMENTS IN CAPITAN QUADRANGLE, NEW MEXICO

RAYMOND SIDWELL,
Texas Technological College, Lubbock, Texas.

ABSTRACT

Mesozoic sediments of the Capitan quadrangle, central Lincoln County, New Mexico, were altered by intrusions of diorite and diorite porphyry dikes and by displacement movements along some of the dikes. The apparent effects of the two processes extend laterally about 30 feet on either side from the dikes in the sandstones and 20 feet in the limestones and shales. Some of the outstanding changes in the sediments include induration, a change in color, formation of workable beds of coal, replacement of carbonates, and a variation in the mineral content.

INTRODUCTION

The Capitan quadrangle, central Lincoln County, New Mexico, includes a portion of the Sacramento Mountains. The relief drops to lower levels except in a few isolated areas as the Capitan, Carrizo, and Sierra Blanco mountains. A network of dikes breaks through Mesozoic sedimentary rocks, and forms a conspicuous feature of the landscape.

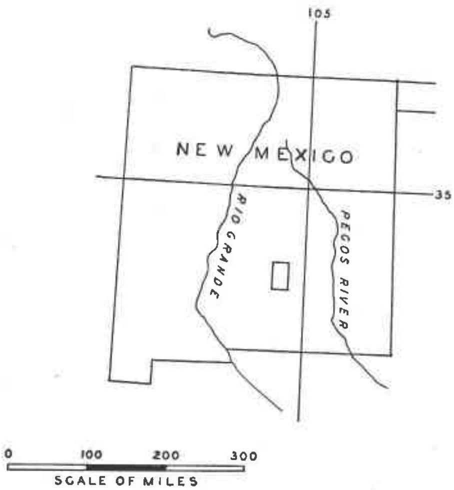

FIG. 1. Map of New Mexico showing the general position of Capitan quadrangle.

This paper deals chiefly with intrusions of diorite and diorite porphyry dikes. These constitute the larges individual intrusions of the area, some attaining a width of 200 feet. Their isolation in most of the quadrangle is sufficient to observe in detail the effects of the intrusions on the adjoining sediments. Although other types of dikes are present in the

Vera Cruz Mountains, they do not always contact directly the sedimentary materials.

Rocks in approximately 75 per cent of the dikes consist of a medium-grained diorite porphyry containing phenocrysts of plagioclase (Ab_9 An_1) feldspar. The core in the zoned plagioclase (about 10 per cent of the phenocrysts) is as basic as andesine (Ab_{65} An_{35}). Pericline in combination with albite twinning is well developed in all phenocrysts. Minerals comprising the ground mass are plagioclase (Ab_9 An_1) feldspar and mafic minerals: magnetite, olivine, and brown hornblende. The feldspar minerals in the ground mass are euhedral with a lath-like arrangement and have well developed pericline-albite twinning. Magnetite grains are small and some appear to be inclusions in olivine and hornblende. Olivine is represented by small euhedral grains that are equally distributed throughout the igneous mass. Mafic minerals constitute about half the ground mass.

Rocks in majority of the diorite dikes are medium to fine grained; a few are basaltic. The predominating black color so characteristic of these dikes is due to the abundance of magnetite and hornblende which overbalance the lighter colored feldspar minerals. Olivine, an abundant mineral, occurs as rounded crystals that are partially enclosed by magnetite and hornblende. Feldspar minerals with the exception of a decrease in plagioclase (Ab_9 An_1) are very similar to those in the ground mass of the diorite porphyry dikes.

Triassic, Jurassic, and Cretaceous sedimentary rocks are exposed in the quadrangle. Triassic sediments, probably the lower Dockum, consist of non-marine, yellow to gray crossbedded sandstones interlensed with thin layers of sandy shale. The Dockum is about 150 feet thick and crops out in the eastern and southeastern portion of the quadrangle. The mineral content in order of abundance is quartz, zircon, tourmaline, rutile, leucoxene, ilmenite, and magnetite.

Jurassic rocks, Morrison formation, are composed of vari-colored, crossbedded, non-marine sandstones and shales that attain a thickness of 125 feet. The Morrison sediments are exposed near the eastern margin of the quadrangle in east-facing escarpments. The minerals in order of abundance are quartz, tourmaline, hematite, magnetite, ilmenite, zircon, mica, leucoxene, and rutile.

The Cretaceous system is represented by the Dakota, Mancos, and Mesaverde formations. The Dakota formation is a compact, conglomeritic, gray, marine sandstone. It is approximately 60 feet thick and caps many of the east-facing escarpments. The minerals in order of abundance are quartz, mica, magnetite, tourmaline, zircon, epidote, and rutile.

The basal portion of the Mancos, the Greenhorn, is a dark compact, fossiliferous limestone. Above the limestone are calcareous shales, Carlile, which are about 140 feet thick and contain large septated concretions. Exposures of the Mancos are widely distributed in the central portion of the quadrangle. The heavy minerals are magnetite, ilmenite, hematite, tourmaline, zircon, and epidote.

The formations comprising the Mesaverde are probably equivalent to the Point Lookout and Menefee in the San Juan Basin, New Mexico (Reeside 1924). The Point Lookout attains a thickness of about 120 feet and consists of three compact sandstones separated by layers of yellow, sandy shale. The sediments are weakly calcareous and contain several fossil horizons. The heavy minerals consist of hematite, magnetite tourmaline, zircon, mica, garnet, and epidote.

TABLE 1. MINERAL CONTENT OF UNALTERED DEPOSITS

Mineral	Dockum	Morrison	Dakota	Mancos	Point Lookout	Menefee
Magnetite	2.1	15.0	28.5	43.0	25.4	45.4
Ilmenite	2.7	12.1		17.5		
Tourmaline	25.9	21.4	15.6	11.4	21.9	9.2
Hematite	.8	18.1		17.5	31.9	
Epidote			5.2	2.6	1.4	6.5
Garnet					2.1	.9
Mica		9.1	41.5		7.5	
Zircon	44.9	12.1	6.6	8.0	9.8	38.0
Rutile	20.8	4.8	2.6			
Leucoxene	2.8	7.4				

The Menefee formation consists of carbonaceous shales and thin layers of dark brown sandstones. The shales are partially indurated and contain large ferruginous concretions. The heavy mineral content of the shales include magnetite, zircon, tourmaline, epidote, and garnet.

METHOD OF PROCEDURE

Field work involved two objectives: one was to note the visible effects of the intrusives on the adjoining sediments; the other was to collect specimens of igneous and sedimentary rocks for laboratory study. Thin sections of the igneous rocks were utilized to determine the mineral content and to classify the intrusions. Specimens of altered and unaltered sedimentary rocks were analyzed to secure the change in the carbonates and mineral content. The carbonates were digested with a weak solution of hydrochloric acid and are represented by the difference in weight of the materials before and after acid treatment. Sedimentary materials were prepared for mineral analysis by the use of acid and by crushing to sand sizes with wooden blocks. After the minerals were separated into the light and heavy fractions by bromoform, the heavy minerals were divided into the magnetic and non-magnetic groups. Percentage composition of the minerals was secured by counting.

Changes in the Sediments

The sediments were altered by two processes: one (probably the more important) was by gases and heat associated with the intrusion; the second, by a displacing movement along some of the dikes. The combined effects of the two processes extended laterally about 30 feet from the dikes in sandstones and usually less than 20 feet in limestones and shales. Some of the changes in the sediments were apparent in the field but laboratory work was essential to reveal others.

Changes observed in the field. The chief visible modifications in sedimentary rocks involved induration, color changes, and coalification. The shales within three feet of the dikes were indurated to the extent of developing foliated characteristics. The color change in shales (with exception of the vari-colored Morrison sediments which developed a brick red) was from gray to almost black. The noticeable effects in sandstones extended four to six feet from the intrusions. These consist of the development of quartzitic characteristics and a change in color from gray to black. The darkening is especially apparent where basaltic dikes cut Dakota sandstone. Slicken-side materials, probably altered sandstones, were distributed throughout the area.

During deposition of the shales in Mesaverde, conditions in Capitan quadrangle favored extensive accumulation of carbonaceous materials. These materials when subjected to the combined effects of the intrusion and displacement movements produced a good grade of bituminous coal. The quality of the coal becomes increasingly inferior with increasing distance from the dikes.

Changes revealed by laboratory work. The principal changes in the sediments disclosed by laboratory work include replacement of carbonates and variation in mineral content. During the period of intrusion, the carbonates were partially and in some cases completely replaced in calcareous sediments and concentrated in the zone of contact. The amount of carbonates replaced varies with the distance from the dikes and the type of sediments. The carbonates in limestones and calcareous shales were modified about 20 feet laterally from the dikes, but complete displacement was limited to a rather narrow band extending less than four feet from the zone of contact. Calcareous sandstones of the area are restricted to the upper Crètaceous, Point Lookout formation. The change of the carbonate content in sandstones (amounting to less than five per cent) was limited to a band four or five feet wide on either side of the intrusions. Carbonates are now concentrated as veins in the contact zone especially along dikes that break through carbonaceous shales. These veins are about one inch thick and are composed chiefly of transparent crystalline calcite.

The variation in mineral content of altered sediments when compared with that of the original deposits is brought about by the introduction of new minerals, and by a change of characteristics in original materials. Introduced minerals (magnetite, olivine, garnet, epidote, mica, and andalusite) apparently came from two sources: some are important constituents of igneous rocks and were probably derived from the intrusion, while others which occur along the zone of contact were quite likely formed during the process of metamorphism. The characteristics of detrital as well as introduced minerals have suffered discernible, alteration.

Magnetite is an important constituent of the original deposits but was probably also introduced into the altered sediments during the intrusion. This is evidenced by a substantial increase in the magnetite content. In addition, there are more conspicuous shiny black metallic grains with minute facets; an increase in the number of altered grains; and magnetite inclusions appear especially in the olivine.

Olivine is a rare mineral in unaltered sediments but becomes abundant in the intrusive rocks. Since the contact zone contains large quantities of olivine, it was very likely introduced by the intrusion. Its abundance in altered sediments ranges from 11 per cent of the heavy minerals in the shales to 17 per cent in sandstones. Detrital olivine consists of irregular fragments of which approximately 75 per cent have been partly altered to iron oxide and a fibrous material (probably serpentine).

Two varieties of garnet, andradite and almandite, are present in the zone of contact. Almandite consists of angular fragments that are characterized by being light pink in color, almost transparent, and by having rectangular surface markings. Andradite in well developed dodecahedrons is limited to the altered calcareous sediments. Garnets in the contact zone make up about three per cent of the heavy minerals in the shales and eight per cent in the sandstones.

The increase in the abundance of epidote in the contact zone suggests that some of the grains were formed during the process of metamorphism. Although epidote is widely distributed in the zone of contact, its maximum concentration appears in altered calcareous sediments.

Two types of mica, muscovite and a brownish-red variety, phlogopite, are present in the altered sediments. As the latter variety is limited to the contact zone, it appears to be a product of metamorphism. It occurs chiefly as pseudo-hexagonal crystals that are almost opaque, and is concentrated in sediments that contain an abundance of iron-bearing minerals. Although muscovite is distributed throughout the contact zone, it is not concentrated in large quantities.

The only place where andalusite occurs is in the contact zone where it is found in well developed prismatic crystals and in greatly fractured grains. Andalusite constitutes less than four per cent of the heavy minerals in the shales and six per cent in the sandstones. Inclusions of carbonaceous materials usually as narrow bands parallel to the long axis of the mineral are common.

Other detrital minerals which are a part of the original deposits include quartz, tourmaline, and zircon. Of these, quartz has undergone apparent changes. It is represented as transparent fragments with conchoidal fracture and as reddish-brown, sub-rounded grains with a tendency toward elongation. Compared with the original deposits the principal changes are: numerous dark grains apparently resulting from impurities brought in by intrusives, the development of parallel lamellae (platy quartz) in about 10 per cent of the grains, and strain shadows and crenulated borders in many of the sub-rounded grains.

Summary

Sediments in Capitan quadrangle have been altered by the combined effects of the igneous intrusions and displacement movements adjacent to the dikes. Changes in these sediments involve: induration, color change, coalification of carbonaceous sediments, replacement of calcareous materials, introduction of new minerals, and a change in the characteristics of the original detrital minerals.

Reference

Reeside, J. B. Jr. (1924), Upper Cretaceous and Tertiary formations of western part of the San Juan Basin, Colorado and New Mexico: *U. S. G. S.*, *Prof. Paper* **134**, p. 9.