Multiple intrusions in the San Miguel Mountains, Colorado

Calvin S. Bromfield and Alfred L. Bush

1968, pp. 94-99. https://doi.org/10.56577/FFC-19.94

in:

San Juan, San Miguel, La Plata Region (New Mexico and Colorado), Shomaker, J. W.; [ed.], New Mexico Geological Society 19th Annual Fall Field Conference Guidebook, 212 p. https://doi.org/10.56577/FFC-19

This page is intentionally left blank to maintain order of facing pages.

MULTIPLE INTRUSION IN THE SAN MIGUEL MOUNTAINS, COLORADO'

By

CALVIN S. BROMFIELD AND ALFRED L. BUSH
U.S. Geological Survey, Denver, Colo.

INTRODUCTION

W. H. Holmes, the famous artist-geologist, visited the western San Miguel Mountains briefly in the summer of 1876 and recognized the laccolithic features of some of the intrusions. Cross and Purington (1899) established the basic geologic framework of the eastern half of the San Miguel Mountains, as a part of Cross' and co-workers' extensive geologic studies in the San Juan Mountains. In recent years the U.S. Geological Survey has undertaken studies in the western San Juan Mountains which includes the San Miguel Mountains. This articles describes briefly the regional geologic setting and some aspects of multiple intrusion in the San Miguel Mountains and is chiefly a summary of published data (Bromfield, 1961, 1967; Bush and Bromfield, 1966).

GENERAL GEOLOGIC SETTING

The San Juan Mountain region of southwest Colorado, an area of several thousand square miles, is composed in large part of a vast volcanic pile of Tertiary age which has been deeply dissected into a rugged mountainous region. Erosion has exposed underlying rocks ranging in age from Precambrian to Mesozoic. On the west this mountainous region descends abruptly to the lower, generally flat-lying, sedimentary rocks of the great Colorado Plateau.

The San Miguel Mountains are a west-trending outlier of the San Juan Mountains that rises abruptly from the mesa surface of the Colorado Plateaus Province to elevations of over 14,000 feet (fig. 1). Their principal geologic feature is an extensive east-west zone of intrusion into nearly flat-lying sedimentary and volcanic rocks of Mesozoic and Tertiary age. At the west end a group known as the Dolores Peaks is formed by the Dolores Peak stock and associated laccoliths; about 3 miles to the east the Wilson Mountains, a larger group, have the Wilson Peak stock and the dual eastward-trending prongs of the Black Face and Ames plutons as their dominant geologic feature. The size and relation of these intrusive bodies can best be understood by reference to figures 2 and 3.

STRATIGRAPHY

In the San Miguel Mountains the outcropping sedimentary rocks range in age from Late Jurassic to Eocene and aggregate approximately 4,000 feet in thickness. Overlying them are about 1,000 feet of Tertiary tuffs, breccias,

'Publication authorized by the Director, U. S. Geological Survey

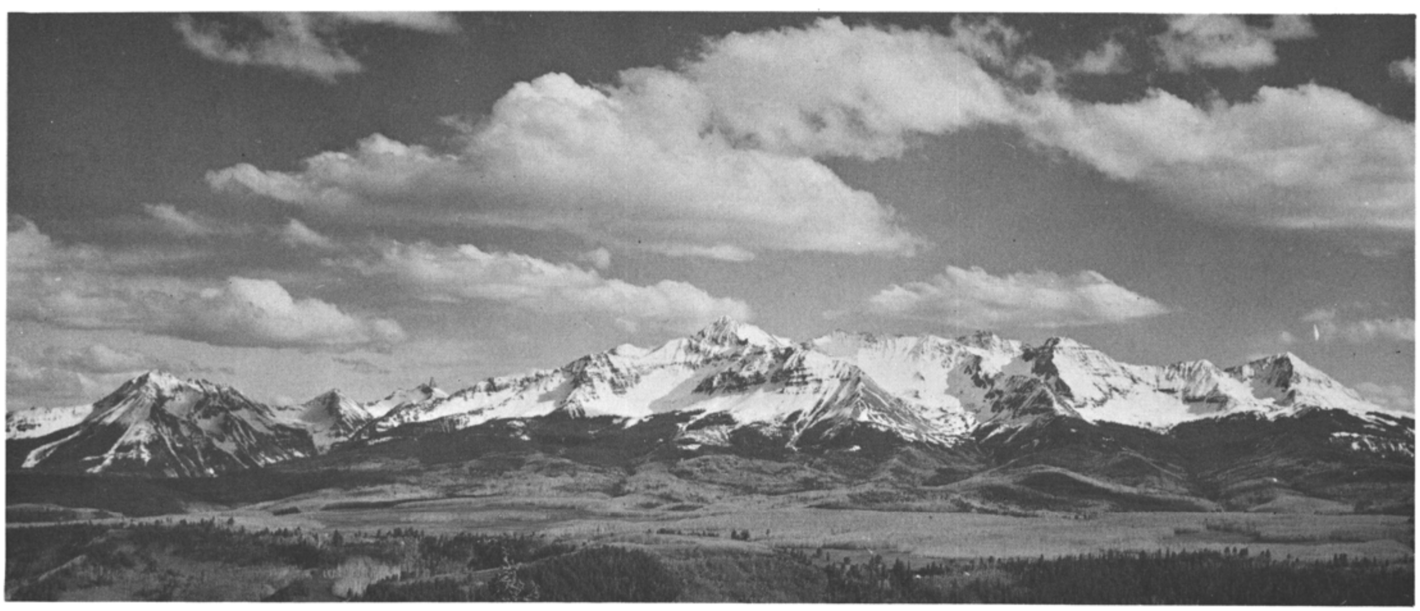

FIGURE 1.
North face of the eastern San Miguel Mountains. Main peaks (left to right) are Sunshine Mountain (12,930) feet), the spire of Lizard Head (13,113) feet), and Wilson Peak (14,017 feet).

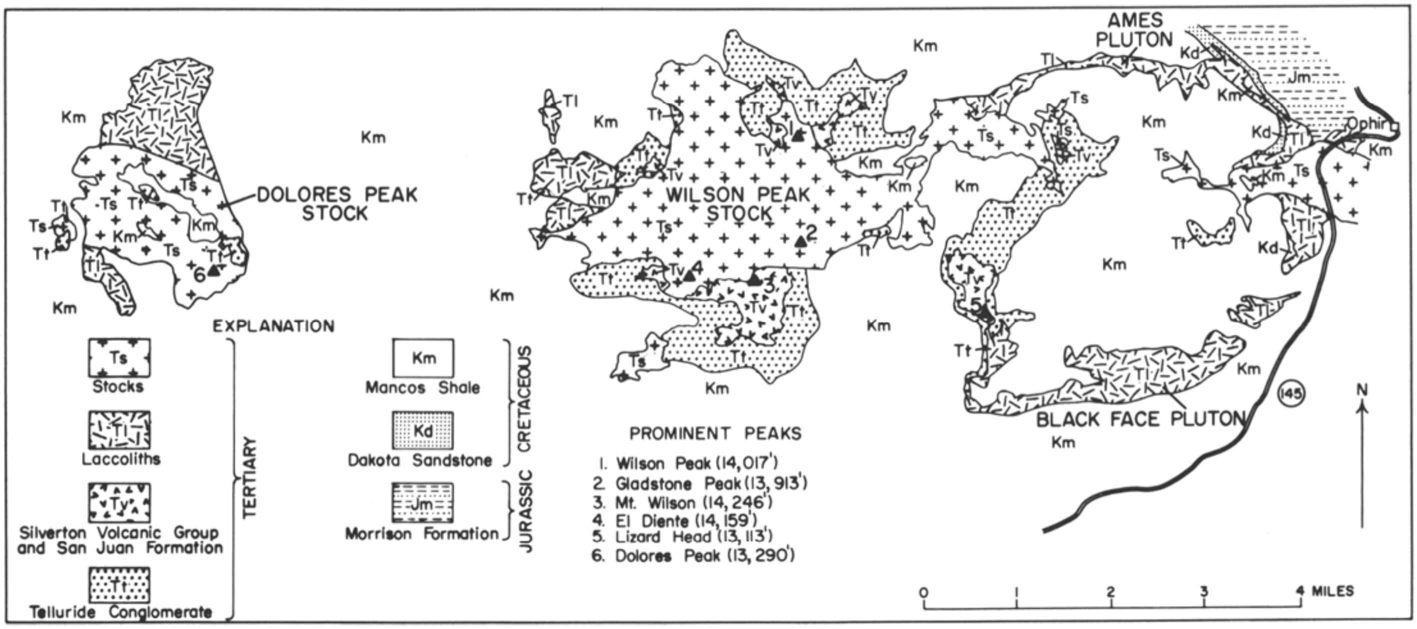

FIGURE 2.

Simplified geologic map of the San Miguel Mountains, San Miguel and Dolores Counties, Colorado showing relation of plutons and laccoliths to the stocks that constitute the main mountain masses.

and flows. Various surficial deposits of Quaternary age—talus, rock streams, landslide deposits, glacial deposits—locally cover the older rocks.

The oldest sedimentary unit exposed is the Upper Jurassic Salt Wash Sandstone Member of the Morrison Formation which is found along the valley of the Lake Fork of the San Miguel River in the extreme northeast corner of the area. This is overlain by the Brushy Basin Shale Member of the Morrison Formation. The Morrison Formation in turn is overlain disconformably by the Lower (?) and Upper Cretaceous Dakota Sandstone and the thick marine shales of the Upper Cretaceous Mancos Shale, the most widespread of the outcropping formations. The Eocene Telluride Conglomerate overlies the Mancos Shale with a very slight angular unconformity. The highest rock units, both stratigraphically and topographically, are the San Juan Formation of Oligocene or older age, and a part of the Silverton Volcanic Group of middle to late Tertiary age. These units overlie the Telluride Conglomerate and along some of the high ridges form scattered erosion remnants of a volcanic sequence once continuous with the thick San Juan volcanic pile just east of the map area.

The relation and relative thickness of the stratigraphic units are shown in table 1.

INTRUSIVE ROCKS

BLACK FACE AND AMES PLUTONS

The Black Face pluton forms an elongate east-trending body southeast of the Wilson Peak stock (fig. 2). The Ames pluton, east of the stock and in contact with it, forms a narrow outcrop which crosses the northeast part of the area (fig. 2); the outcrop makes a spectacular cliff along the west side of the Lake Fork of the San Miguel River about a mile west of Ophir where it takes the form of a sill as much as 800 feet thick. The Ames and Black Face plutons probably connect in the subsurface. Both plutons are composed of granodiorite porphyry of identical appearance.

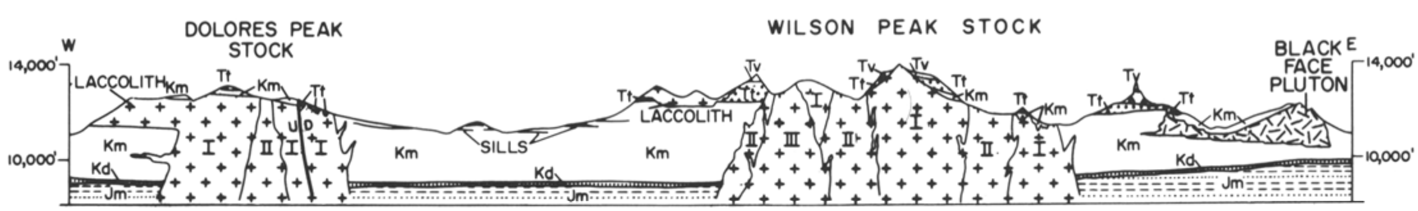

FIGURE 3.

Diagrammatic, generally east-trending geologic section of the San Miguel Mountains, Colorado. I, II, III, oldest to youngest intrusive phases of composite stock rocks. Other symbols as on figure 2.

The typical rock is medium to dark gray on fresh fracture, and its texture is everywhere porphyritic. Through increase in coarseness of the groundmass, much of the rock is seriate porphyritic, whereas in some places the contrast between phenocrysts and groundmass is more distinct and the rock is more nearly a true porphyry. Phenocrysts of plagioclase, clinopyroxene, hornblende, and rarely orthopyroxene, which range in size from 0.5 to 3.0 mm, are set in a groundmass of plagioclase, potassic feldspar, and quartz which ranges from 0.01 to 0.2 mm in grain size. The mafic phenocrysts tend to cluster together and give the rock a characteristic mottled or dark flecked appearance.

In a few places the granodiorite porphyry contains swarms of inclusions, principally of Precambrian rocks carried up from the basement, which here is a minimum of 6,000 feet below the outcrop. One of these inclusion swarms is strikingly exposed, near the field trip route just south of Ames, along the abandoned narrow-gauge railroad bed at the tight switchback known as Ophir Loop (about half a mile west of Ophir).

The form of the Black Face pluton and its relations to the country rock suggest that it is an asymmetric laccolith, though no floor has been exposed by erosion. The roof rocks are still preserved near the summit of Black Face and at the east end of the intrusive mass. At both places the cap of Mancos Shale lies at relatively low angles in concordant relation to the underlying granodiorite porphyry. To the north the strata gradually arch over into steeper dips, concordantly following the intrusive's roof.

In contrast, along the south side of the Black Face pluton the Mancos Shale is at steep angles, commonly vertical to overturned, and probably in part is faulted parallel to the contact. Locally adjacent to the pluton, overturned Mancos Shale beds dip at 30°-70° into the contact. The Mancos Shale is crumpled into small-scale overturned folds which diminish in intensity outward and pass into normal flat-lying strata within a thousand feet of the intrusive contact. The pluton itself apparently has a somewhat irregular but steep south-dipping contact along much of its south side, but in places it is vertical.

As with the Black Face pluton, the Ames pluton has both concordant and discordant relations to the enclosing flat-lying sedimentary rocks and thus is not readily classified, but in general it has the form of a thick irregular sill. Near the Wilson Peak stock, the Ames pluton is a discordant body adjacent to which the strata are domed and crumpled. The body grades northeastward into a sill 600 to 800 feet thick.

TABLE 1. SEDIMENTARY AND VOLCANIC ROCKS OF THE SAN MIGUEL MOUNTAINS, COLORADO

AGE	FORMATION	DOMINANT LITHOLOGY	APPROXIMATE MAXIMUM EXPOSED THICKNESS (ft.)
Late and middle Tertiary	Silverton Volcanic Group	Pale-red lithic-crystal tuff, greenish to dark-purple andesitic to dark quartz latitic breccia, and dark-brown pyroxene andesite flows; forms cliffs and steep slopes.	700
	Unconformity		
Oligocene or older	San Juan Formation	Grayish-green to purple andesitic to quartz-latitic tuffs, tuff breccias, and tuffaceous sandstones; in part water laid; forms cliffs and steep slopes.	600
Eocene	Telluride Conglomerate	Pale-red arkosic conglomerate, sandstone, and siltstone; contains some thin red to gray claystones; forms cliffs.	1,000
	Unconformity		
Late Cretaceous	Mancos Shale	Gray to black marine shale, a thin fine-grained sandstone unit in places near top, and a few thin fossiliferous limestone beds, mostly near the base, forms wooded slopes above mesa rims.	2,500
Late and Early (?) Cretaceous	Dakota Sandstone	Interbedded sandstone and carbonaceous shales at top; interbedded carbonaceous shales, siltstones, some thin coal beds, and a few thin sandstones in middle; light-colored conglomeratic sandstone and conglomerate at base; forms alternate cliffs, slopes, and ledges.	200
	Unconformity		
Late Jurassic	Morrison Formation	Brushy Basin Shale Member; variegated red to green mudstones and thin-bedded very fine grained sandstones; most units limy; forms covered slopes.	500
Late Jurassic	Morrison Formation	Salt Wash Sandstone Member: light-colored thick lenticular crossbedded medium-grained sandstones and some thin interbedded red-brown to gray-green mudstones; forms cliffs, ledges, and slopes.	450

WILSON PEAK STOCK

The highest and most impressive group of peaks in the San Miguel Mountains, several of which reach above 14,000 feet, have the Wilson Peak stock at their core (fig. 2) . The stock forms Wilson Peak, Gladstone Peak, El Diente, and the north slopes of Mount Wilson, and it underlies a large part of the mountain spurs and basins which surround these peaks. It is exposed through a vertical range of 4,000 feet, and underlies an area of about 5 square miles. The stock is composite and is composed of microgranogabbro, granodiorite, and porphyritic adamellite, intruded in that order (see units I, II, III on figure 3).

The typical microgranogabbro is medium-dark-gray to medium-light-gray granular rock with an average grain size of less than 1 mm. Under the microscope the rock shows a granular texture and is composed of about 50-68 percent plagioclase, 5-10 percent orthoclase, 6-15 percent quartz, and 15-25 percent mafic minerals, which include varying proportions of clinopyroxene, sparse orthopyroxene, biotite, and hornblende. Clinopyroxene or biotite may be dominant and lesser amounts of hornblende are usually present, generally as mantles over pyroxene. The accessory minerals are chiefly magnetite and apatite.

The granodiorite is medium grained; it has an average grain size of 1-2 mm, and is generally medium gray to light gray flecked with darker mafic grains. In most exposures the rock is massive; rarely, as in Navajo Basin in the western part of the Wilson Mountains, contorted vertical flow banding is present. The granodiorite has granular texture and contains about 35-50 percent plagioclase, 15-30 percent potassic feldspar, 6-12 percent quartz, and 15-25 percent mafic minerals. In some rocks the dominant mafic mineral is clinopyroxene, in others hornblende, and in a few biotite, but all three minerals are everywhere present. Orthopyroxene is rare.

Porphyritic adamellite is the youngest rock within the Wilson Peak stock and occurs only in the central part. It intrudes the granodiorite in Navajo and Bilk Basins and intrudes the microgranogabbro in Silver Pick Basin; mutual contacts are generally sharp.

The adamellite is a medium-grained massive rock characterized by potassic feldspar phenocrysts which average about 1 cm in length. The phenocrysts make up 20-30 percent of the rock in some places, and 10 percent or less in others. The groundmass averages about 2 mm in grain size. The rock is generally light gray to very light gray, and is distinctly lighter colored than the granodiorite or microgranogabbro. The lighter tone is due partly to coarser grain size and partly to a smaller content of mafic minerals.

The adamellite groundmass is composed of plagioclase, potassic feldspar, quartz, and small amounts of hornblende and biotite. In some thin sections, clinopyroxene is present in small amounts, but in most sections it is absent.

The Wilson Peak stock is predominantly discordant to the enclosing sedimentary rocks, and its contacts are steep and sharp. Around somewhat more than half its periphery, the flat-lying strata of the Mancos Shale and overlying Telluride Conglomerate continue up to the stock contact with no significant deformation. This relationship holds in general from near Mount Wilson on the southern boundary of the stock west into Navajo Basin, then east and north along the stock contact into Silver Pick Basin.

On the northeast, however, along the ridge leading east from Wilson Peak, the Telluride Conglomerate and Mancos Shale dip away from the stock contact. The steep intrusive contact cuts upward across the bedding planes of the enclosing rocks, and, though it parallels the strike of the beds in places, it cuts discordantly across the strike of the tilted beds in others. On its southeast side the stock transects the large asymmetrical overturned fold thought to be related to the intrusion of the Black Face mass. The stock cuts the fold at nearly right angles to the anticlinal axis and is interpreted to be later than the fold.

DOLORES PEAK STOCK AND SATELLITIC LACCOLITHS

The smaller group of peaks at the west end of the San Miguel Mountains are developed upon the Dolores Peak stock and a pair of laccoliths that extend from it, one to the north and a smaller one to the southwest (fig. 2). The stock is a northwest-trending, broadly elliptical body about 2 miles long by 1 mile wide, that underlies nearly three-fourths of the mountain mass and is exposed over a vertical range of more than 2,000 feet; it forms several peaks that reach above 13,200 feet. The intrusive rocks cut both the Mancos Shale and the westernmost exposures of the Telluride Conglomerate and have both concordant and discordant contacts with them.

Like the Wilson Peak stock, the Dolores Peak stock is a composite mass, made up of rocks that range from granogabbro to granodiorite. The sequence of intrusion is not as clear, but in general, it appears to have begun with granogabbro predominant over granodiorite, and ended with a central granodiorite unit being intruded into a mixed granodiorite-microgranodiorite suite (see units I and II on fig. 3) . Most of the stock is composed of the mixed granodiorite-microgranodiorite suite; the rocks are light to dark gray, mostly porphyritic, and the feldspar phenocrysts (andesine and labradorite) are commonly strongly zoned. At its east end the stock has a border zone up to several tens of feet thick that contains numerous inclusions of Precambrian rocks, similar in character, though not in amount, to the inclusion swarms in the Ames pluton.

The central core of the stock is an elongate, steep-walled mass of light-gray, fine- to medium-grained granodiorite, porphyritic to even grained, with andesine feldspar that is moderately to strongly zoned. Whereas contacts in the mixed granodiorite suite range from gradational to sharp, the contact of the core granodiorite with the mixed-suite rocks is usually sharp.

At almost all exposures the stock has a discordant contact with the enclosing rocks. At its southeast end the stock cuts directly across the Telluride Conglomerate, whose varied attitudes probably reflect an adjustment to the emplacement of igneous rock below, before piercement by the crosscutting mass. To the northwest, Mancos Shale roofs the highest exposures of the stock, so that its uppermost penetration into the Tertiary rocks is closely limited.

The prominent laccolith that extends about a mile north from the stock is composed mostly of granogabbro, much of which is porphyritic. The feldspar generally is labradorite and is strongly zoned. The floor of the laccolith is visible at a few places, and the Mancos Shale into which the laccolith is intruded is baked to a hornfels for a few feet below the contact. Near its southern junction with the stock the laccolith's roof of Mancos Shale is preserved, and locally the attitude of the Mancos mirrors the upper surface of the laccolith. Elsewhere the Mancos is preserved on the eastern flank of the laccolith, where it mantles the intrusive body through a vertical range of some 600 feet.

DEPTH OF INTRUSION

Only general estimates can be made as to the amount of cover over the Wilson Peak and Dolores Peak stocks and the other plutons at the time of their intrusion. The stocks now form some of the highest peaks in the area, and they intrude Mesozoic sedimentary rocks, and the Tertiary Telluride Conglomerate, San Juan Formation, and the Silverton Volcanic Group. At the time of intrusion the Potosi Volcanic Group probably also extended over much of the area, inasmuch as it is exposed to the north and east as erosion remnants capping the highest ridges of the western San Juan Mountains, and it is found nearby to the south in old landslide blocks. Vhay (1962) gave a maximum thickness of about 1,150 feet for the Potosi and 1,400 feet for the Silverton in the area south of Telluride and just northeast of the San Miguel Mountains. The cover above the present levels of observation probably was less than a mile, and perhaps it was as little as 2,000 feet when the stocks were emplaced.

MODE OF EMPLACEMENT

The intrusion of the Wilson Peak stock and the associated Black Face and Ames intrusive bodies produced two contrasting effects on the nearly flat-lying strata of Mesozoic and Tertiary age, dependent on the mode of emplacement. The form and relations of the Black Face and Ames plutons suggest that they are laccoliths or, in part, thick sills, and they apparently made room for themselves primarily by doming or lifting their roof rocks and locally by pushing strata aside. The later Wilson Peak stock was emplaced primarily by piecemeal stoping, and adjacent flat-lying strata were not appreciably disturbed.

Several lines of evidence suggest piecemeal stoping as the important intrusive mechanism in the emplacement of the Wilson Peak stock. Some doming and upward punching may have occurred near the northeast edge of the stock during intrusion of an early granogabbro, but if this mode of emplacement was widespread the evidence has been obliterated during the final intrusion. Along much of the stock contact the flat-lying strata are essentially undisturbed and the relation of the sedimentary rocks to the stock indicates that a considerable volume of country rock has disappeared. In plan the outline of the stock is irregular. The contacts of the stock with the country rocks are sharp, predominantly vertical, irregular in detail, and discordant.

Piecemeal stoping is strongly suggested also by irregular apophyses, dikes, and sills which may have acted as wedges to pry off blocks of country rocks; by reentrants of the stock along bedding planes and fracture surfaces in the country rocks, resulting at places in a steplike pattern of outcrop both laterally and vertically; and by the presence locally of angular inclusions of wallrock near the contacts. These features are observed through a vertical interval of at least 2,000 feet.

Additional processes appear to have been operating in the emplacement of the Dolores Peak stock. Piecemeal stoping was still an important mechanism, for 1.) a significant volume of the sedimentary rocks have disappeared, 2.) regionally the attitudes of the beds have not been disrupted very much, and 3.) the contacts are sharp, irregular, discordant, and mostly steep to vertical. However, in places along the southwest and west sides of the stock, attitudes in the Mancos Shale suggest that the stock made room for itself by a combination of shouldering and stoping. Doming of the overlying rocks is visible in the preserved remnants of the roof, where both concordant and discordant attitudes are present. Along the southeast end of the stock, emplacement of the igneous rock caused differential movement in the invaded rocks, so that Mancos Shale lying on the stock has been raised at least 900 feet above the base of the Telluride Conglomerate, which also lies upon the stock. A breccia zone that separates the two masses of sedimentary rock represent the "igneous" fault. It seems clear, therefore, that forceful piercement of enclosing rocks also was a significant intrusive mechanism.

AGE OF THE MAJOR INTRUSIVE ROCKS

The Wilson Peak stock intrudes the Eocene Telluride Conglomerate and the middle Oligocene or older San Juan Formation and the middle and upper Tertiary Silverton Volcanic Group, and thus is younger than these units. The intrusive relations of the Wilson Peak stock to the volcanic rocks are paralleled by several intrusive masses in the western San Juan Mountains; the Stony Mountain stock (Dings, 1941), the Sultan Mountain stock (Cross, and others, 1905), the Ophir stock (Cross and Purington, 1899), and the Grizzly Peak stock (Cross and Purington, 1899) all cut the middle and upper Tertiary volcanic rocks.

The Black Face and Ames plutons intrude rocks as young as the Telluride Conglomerate, but are not found in contact with the volcanic rocks. From the fact that a fold in the country rock, thought to be related to the intrusion of granodiorite porphyry of the Black Face pluton, is truncated by the Wilson Peak stock, it is inferred that the Black Face pluton is older than the stock. However, the contacts between granodiorite porphyry of the Black Face and Ames plutons and the micrograno-gabbro of the Ophir stock south of Ames and just east of the area suggest liquid mixing along their mutual contacts, and it is inferred that emplacement of the Black Face and Ames plutons, though somewhat earlier, was followed very shortly by the earliest phase of the stock intrusions. If this inference is correct, then the Black Face and Ames plutons are also of middle and late Tertiary age.

The Dolores Peak stock and associated laccoliths intrude the Telluride Conglomerate. No volcanic rocks are now present in the area of the intrusive bodies, but lacking any other evidence it seems likely the Dolores Peak intrusive bodies are also of middle and late Tertiary age.

REFERENCES

Bromfield, C. S., 1961, Emplacement of the Wilson Peak stock and associated intrusive rocks, San Miguel Mountains, Colorado, in Short papers in the geologic and hydrologic sciences: U.S. Geol. Survey Prof. Paper 424-C, p. C137-C139.

——— 1967, Geology of the Mount Wilson quadrangle, western San Juan Mountains, Colorado: U.S. Geol. Survey Bull. 1227, 100 p.

Bush, A. L., and Bromfield, C. S., 1966, Geologic map of the Dolores Peak quadrangle, Dolores and San Miguel Counties, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-536.

Cross, Whitman, Howe, Ernest, and Ransome, F. L., 1905, Description of the Silverton quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 120, 34 p.

Cross, Whitman, and Purington, C. W., 1899, Description of the Telluride quadrangle, Colorado: U.S. Geol. Survey Geol. Atlas, Folio 57, 19 p.

Dings, M. G., 1941, Geology of the Stony Mountain stock, San Juan Mountains, Colorado: Geol. Soc. America Bull., v. 52, no. 3, p. 695-720.

Vhay, J. S., 1962, Geology and mineral deposits of the area south of Telluride, Colorado: U.S. Geol. Survey Bull. 1112-G, p. 209-310 [1963].