

The first detailed geologic mapping in the lower Matanuska Valley of south-central Alaska was done in 1910 by Martin and Katz (1912), who recognized the principal structural features and stratigraphic units and described and sampled many coal beds. Since that time much new information has become available as a result of mine development and detailed geologic investigations of the more promising coal deposits. A report by Capps (1927) extended detailed geologic mapping from the Chickaloon River eastward to the limits of the Matanuska coal field and also covered the southern margin of the field east of Kings Mountain. In 1925 a reconnaissance of the area between the Knik and Matanuska Rivers by Landes (1927) revealed the presence of a belt of Tertiary rocks containing some coal along the south side of the Matanuska Valley northeast of Wolverine Creek. An investigation of the coal deposits of the Wishbone Hill district by Barnes and Payne (1956) resulted in a large-scale detailed map of the area between Moose and Eska Creeks, and later work by Barnes in 1956 and 1958 extended the mapping eastward to include the Knob Creek area. Detailed mapping of the Little Susitna district in 1952-54 (Barnes and Sokol, 1959) extended into the northwest corner of the present

INTRODUCTION

The present map was prepared in order to present, on a modern topographic base, the latest and most complete information on the character, distribution, structure, and relations of the coal-bearing Chickaloon formation and associated rocks of the Matanuska coal field. As many parts of the field were known only from brief geologic reconnaissance, the writer, assisted by M. C. Blake, spent about 5 weeks in 1960 mapping these little-known areas and field checking critical localities in other parts of the coal field. Helicopters, available on charter from Anchorage, were used to reach many widely scattered and remote localities and for aerial reconnaissance. The resulting map, together with maps of the upper Matanuska Valley to the east (Capps, 1927, pl. 2; Waring, 1936, pls. 2, 3) and of the Little Susitna district to the west (Barnes and Sokol, 1959, pl. 7) provides detailed (1:63,360) geologic map coverage of the entire Matanuska coal field. Compilation of the present map involved in large part the transfer, with some revisions, of geology from the older maps to the latest topographic base maps (U. S. Geol. Survey 1:63,360 series, 1951, 1952). The principal revision of earlier mapping consisted of showing as bedrock only those areas where the identity of the underlying formation could be reliably inferred either from outcrops or from surface expression. Consequently several areas, such as the lowlands between the Kings and Chickaloon Rivers, which appear as bedrock on the older map (Martin and Katz, 1912, pl. 5) but which aerial reconnaissance and study of aerial photographs show to be deeply covered with glacial deposits, are shown as Quaternary on the present map. Also, as it was not feasible to attempt to trace the boundaries between stream, terrace, and glacial deposits in all parts of the area, they are shown as a single unit.

map area.

BEDDED ROCKS

Sedimentary rocks, ranging in age from Jurassic to Tertiary and of both marine and nonmarine origin, underlie most of the lower Matanuska Valley. They consist primarily of clastic rocks, including all gradations from claystone to conglomerate; a few small areas of limestone have been mapped north of Castle Mountain. In addition, highly altered dominantly pyroclastic rocks of Early Jurassic age are present along the south margin of the valley and north of Castle Mountain, and two small remnants of interbedded basaltic lava and tuff, of Tertiary age, cap the highest peaks of Castle Mountain. Sedimentary, intrusive, and volcanic rocks have been mapped in about 60 percent of the present map area; the remaining 40 percent is mantled with unconsolidated alluvial and glacial deposits.

TALKEETNA FORMATION

Bedded rocks, mainly of volcanic origin, including tuff, breccia, and a few lava flows, generally altered to a dense light- to dark-green "greenstone", form the slopes of the Chugach Mountains along the southern margin of the Matanuska Valley. These rocks are overlain unconformably by the Cretaceous and Tertiary rocks of the valley floor. They have been correlated with similar rocks that compose the Talkeetna formation, of Early Jurassic age, (Capps, 1927, pl. 2) which occurs widely in the eastern Talkeetna Mountains, including a small part of the present map area north of Castle

NAKNEK FORMATION

Mountain.

The only known occurrence in the lower Matanuska Valley of the Naknek formation, of Late Jurassic age, is a small exposure of siltstone and shale containing limestone concretions at the head of a small gorge on the north side of Wolverine Creek. These rocks, which contain Upper Jurassic fossils, have been highly deformed and are overlain unconformably by shale and sandstone of the Matanuska formation, which in turn is overlain unconformably by basal conglomerate of the Chickaloon formation.

UNNAMED LIMESTONE FORMATION

Massive limestone, in which bedding in most places has been obliterated by shattering and recrystallization, occurs in a narrow belt on the ridge north of Castle Mountain (Martin and Katz, 1912, p. 33). The formation consists mainly of blue and gray to white, fine- to medium-grained limestone, but masses of chert and cherty limestone are common. No fossils have been found in the limestone, but, on the basis of its unconformable relationship to underlying Lower Jurassic greenstone and correlation with rocks of neighboring regions, it has been provisionally referred to the Lower Cretaceous.

ARKOSE RIDGE FORMATION

A formation consisting of at least 2,000 feet of highly indurated arkose, shale, and conglomerate has been mapped along most of the northwest border of the lower Matanuska Valley, where it has been thrust up along the Castle Mountain fault against the Matanuska and younger formations. On Arkose Ridge the formation is dominantly arkose, grading locally into conglomerate, but it includes many thinner beds of dark shale. North of Castle Mountain rocks considered to be of the same formation (Martin and Katz, 1912, p. 40-41) consist of about equal amounts of conglomerate, sandstone, and shale. Although plant fossils are abundant in many of the shaly beds, indicating a continental origin, no significant coal beds have been found in the formation. The Arkose Ridge formation was originally assigned a Tertiary age on the basis of the plant fossils, but later studies indicate that it is Cretaceous in age (Barnes and Payne, 1956, p. 10-12; Grantz and Wolfe, 1961, p. 1762).

contact on Jurassic granitic rocks of the Talkeetna batholith (Martin and Katz, 1912, p. 41), but its stratigraphic relations to other formations are less clear, as all observed contacts are faults. However, the fact that the arkosic rocks are on the upthrown side of the Castle Mountain fault opposite rocks of the Matanuska formation strongly suggests that they underlie at least part of the Matanuska formation.

The Arkose Ridge formation rests with sedimentary

MATANUSKA FORMATION

At the type locality on Granite Creek the Matanuska formation has an aggregate thickness of at least 4,000 feet, of which the lower half is practically all shale and the upper half is interbedded sandstone and shale, the sandstone predominating (Martin, 1926, p. 318). A few thin conglomerate beds are included. The formation is mostly of Late Cretaceous age, but recent studies by Grantz and Jones (1960, p. 349-350) indicate that as mapped by earlier workers it includes beds of late Early Cretaceous age. It is dominantly of marine origin, although plant fossils from localities on the lower

Kings River and the Matanuska River below Suttonindicate that part of the formation, probably the upper part, includes rocks of continental or nearshore origin. It is exposed at many places throughout the Matanuska Valley and probably also underlies areas of Tertiary rocks and many areas covered with Quaternary deposits. The Matanuska formation rests unconformably on Lower Jurassic volcanic rocks south of the Matanuska River (Capps, 1927, p. 36), but its relations to the Arkose Ridge formation and the overlying Chickaloon formation are not known, as all observed contacts are faults. In some parts of the Wishbone Hill and Knob Creek areas a general concordance in the trend and degree of folding between beds of the Matanuska and the nearby Chickaloon strata suggests that they may be conformable; on the other hand the proximity of moderately folded Chickaloon strata at the mouth of Moose Creek and vertical Matanuska strata along the Matanuska River 1 mile to the east suggests an unconformable relationship. (See section

CHICKALOON FORMATION

The Chickaloon formation, of continental origin and Paleocene or Eocene age, consists of at least 5,000 feet of interbedded claystone, siltstone, feldspathic sandstone, and conglomerate and includes many beds of bituminous coal in the Wishbone Hill and Chickaloon districts. Most of the coal beds in the Wishbone Hill district are in the upper 1,400 feet of the formation (Barnes and Payne, 1956, p. 14); those in the Chickaloon district appear to be about midway between the top and bottom of the formation (Capps, 1927, p. 42). Conglomerate, except for a few scattered thin beds grading into pebbly sandstone, is present only in the lower part of the formation, which is best exposed along the base of Arkose Ridge and in the Little Susitna River canyon, and along the front of the Chugach Mountains near Wolverine Creek. In both areas many massive beds of conglomerate as much as 50 feet thick are interbedded with shale and sandstone.

The Chickaloon formation occurs throughout the lower Matanuska Valley, interspersed with areas of older sedimentary rocks and younger intrusive rocks. It also probably underlies all areas of younger Tertiary formations and much of the area covered with Quaternary deposits. Field work in 1960 added several square miles to the known area underlain by the Chickaloon formation—along the south base of Arkose Ridge, along the north front of the Chugach Mountains between Lazy and Pinnacle Mountains, and in the Little Granite Creek

In the Wishbone Hill district the Chickaloon formation is overlain conformably by the Wishbone formation, into which it grades by upward increase in the proportion of conglomerate and sandstone (Barnes and Payne, 1956, p. 18). In the Chickaloon district Waring (1936, p. 14) reports that Chickaloon strata on the Chickaloon River are "overlain without apparent unconformity by massive beds of conglomerate." Capps, on the other hand (1927, p. 42), states that the relation of the Chickaloon formation to the overlying conglomerate is unconformable, but he gives no evidence for this conclusion. The Chickaloon formation was assigned an Eocene age on the basis of plant fossils (Martin and Katz, 1912, p. 52), but regional relations suggest that it may be Paleocene.

WISHBONE FORMATION

The Wishbone formation, which, with the overlying Tsadaka formation, was originally mapped as the Eska conglomerate (Martin and Katz, 1912, pl. 5), forms the main mass of Wishbone Hill between Moose and Eska Creeks and of Castle Mountain between the Kings and Chickaloon Rivers. The formation has a maximum thickness of about 2,000 feet on Wishbone Hill and 3,000 feet on Castle Mountain. In both areas it consists predominantly of conglomerate but includes many interbeds of crossbedded feldspathic sandstone, a few lenticular beds of siltstone, and some claystone. The conglomerate consists of firmly cemented pebbles of fine-grained igneous and metamorphic rocks, chert, vein quartz, and jasper in a sandy matrix. The formation is overlain unconformably by the Tsadaka formation in the Wishbone Hill district and by volcanic rocks on Castle Mountain. As the Wishbone formation lies conformably on and grades into the Chickaloon formation, it is considered to be Paleocene(?) or early Eccene(?) in age.

TSADAKA FORMATION

The Tsadaka formation consists of at least 700 feet of poorly indurated coarse conglomerate, pebbly sandstone, and siltstone. The conglomerate is characterized by cobbles and boulders of coarse-grained granitic rocks. This formation has been identified only on the southwest slopes of Wishbone Hill, where it rests unconformably on more strongly folded beds of the Wishbone formation, and in Tsadaka Canyon on lower Moose Creek, where nearly flat beds of cobble conglomerate overlie strongly folded Chickaloon strata. In the absence of fossil evidence the Tsadaka is assumed to be Eocene or younger in age.

BASALTIC LAVA AND TUFF

The youngest consolidated rocks in the lower Matanuska Valley are the interbedded lava, tuff, and breccia of basaltic composition that rest unconformably on conglomerate of the Wishbone formation in two small patches on Castle Mountain. These beds are nearly horizontal and have a total thickness of about 700 feet. They apparently are remnants of deposits and flows that still cover broad areas to the north in the Talkeetna Mountains. These rocks were considered by Capps (1927, p. 47) to be of late Tertiary age, possibly Pliocene, but rocks to the northeast that are probably correlative contain plant fossils of Eocene age (Grantz, 1960).

INTRUSIVE ROCKS

Intrusive igneous rocks in the present map area consist of granitic rocks of the Talkeetna batholith, of Jurassic age, and stocks, sills, and dikes of Tertiary age. The granitic rocks consist mainly of mediumgrained grandiorite and quartz diorite. They are not exposed in the Matanuska Valley proper but only along its northern edge, where they appear to be intrusive into the Talkeetna formation, of Early Jurassic age, and are overlain with sedimentary contact by the Arkose Ridge formation (Martin and Katz, 1912, p. 29, 41), which is now considered to be Cretaceous in age (Grantz and Wolfe, 1961,p.1762). Available evidence indicates that the granitic rocks probably are not all of the same age, but were emplaced at various times in the Jurassic period.

Tertiary intrusive rocks are confined largely to the

eastern half of the lower Matanuska Valley, where they

occur as several irregular stocklike masses ranging from a few acres to several square miles in outcrop area, and as countless dikes and sills. West of the mouth of the Kings River the only intrusive rocks mapped are three basaltic dikes in the Wishbone Hill area and two dikes or sills and two small stocks, all of andesitic composition, east of Wolverine Creek.

The Tertiary intrusive bodies include rocks of dioritic, trachytic, and basaltic composition. In general, most of the intrusive bodies east of the Kings River are ba-

trachytic, and basaltic composition. In general, most of the intrusive bodies east of the Kings River are basaltic and those to the west are dioritic and trachytic. The large body west of the mouth of the Chickaloon River was mapped by Martin and Katz (1912, pl. 5) as diorite, and by Capps (1927, pl. 2) as basalt or gabbro. The mass forming the core of Kings Mountain was included by Capps with the basic rocks, but subsequent study by Landes (1927, p. 66-67) showed it to be a volcanic plug composed of rhyolite, which was confirmed by the present writer in

UNCONSOLIDATED QUATERNARY DEPOSITS

Four general types of unconsolidated deposits are present in the lower Matanuska Valley: (1) morainal and outwash deposits, (2) terrace gravel, (3) modern stream deposits, and (4) landslide debris.

Morainal and outwash deposits, consisting of glacial till and gravel, are present throughout the valley, except on the steeper slopes or where they have been removed by recent stream erosion. They are thickest at

lower elevations, especially in the area east of the lower Kings River, between Wishbone Hill and the Matanuska River, and southwest of lower Moose Creek. Terrace gravels occur at low altitudes along the Matanuska River and its tributaries and at high altitudes as gravel benches along the larger tributary valleys, where they apparently were deposited while the main valley was filled with ice to altitudes of as much as 2,200 feet. Stream deposits are present along parts of all the streams but are particularly prominent along the braided course of the Matanuska River. Conspicuous landslides were mapped on the south slope and at the east end of Wishbone Hill and at the west end of Kings Mountain.

STRUCTURE

The lower Matanuska Valley is a structural trough within which all the major structural elements trend northeastward, roughly parallel to the general trend of the valley. The northwest border of the trough is sharply defined by the Castle Mountain fault, along which older rocks of the Talkeetna Mountains have been upthrown against younger rocks of the valley floor. The southeast border is less clearly defined but has been assumed to be also marked by a zone of faulting (Martin and Katz, 1912, p. 74; Capps, 1927, p. 52; Barnes and Payne, 1956, p. 9). However, field work in 1960 along the southeast border revealed no evidence of a major fault zone, but showed that in several places the younger rocks of the valley floor are steeply upturned against the older rocks of the mountain front, suggesting that the south side of the structural trough may be a flexure rather than a fault. In the upper Matanuska Valley, on the other hand, Capps (1927, p. 55) found that the southern border of the valley in some places was a zone of severe deformation and faulting. The rocks of the valley floor have been deformed by moderate to strong folding and faulting along axes with a general northeast trend (see section A-A!). Only two major northeast-trending faults appear on the map, but there are indications of similar faults in other parts of the valley. The two mapped faults are the southeastdipping Moose Creek thrust fault, along the northwest side of Wishbone Hill, and a vertical fault that was traced along the south side of the Matanuska River from the sharp bend above the Kings River to a point opposite Granite Creek. The second fault may be continuous with a similar fault on Wolverine Creek. The anticlinal axis along the Matanuska River between Sutton and Moose Creek very possibly is followed by a fault, separating highly sheared and contorted vertical beds of the Matanuska formation north of the river from moderately dipping beds on the south side. The synclinal axis on Coal

A second type of faulting is represented in the Wishbone Hill district, where several prominent tear faults cut across the axis of the Wishbone Hill syncline. These faults developed at least in part contemporaneously with the folding (Barnes and Payne, 1956, p. 24). Although the structure of the rocks of the valley floor is shown clearly in many places, the overall pattern of folding and faulting is largely obscured by Quaternary deposits. The almost continuous belt of Cretaceous rocks along the Matanuska River between Kings Mountain and Moose Creek probably reflects an anticlinal axis. Tertiary conglomerate in a belt along the southeast margin of the valley is folded into a sharp syncline, which is probably continuous for about 10 miles northeast from Wolverine Creek. Exposures along lower Moose Creek reveal a series of northeasttrending folds, including the Wishbone Hill syncline, which extends about 8 miles northeastward to Knob Creek. The little Granite Creek basin is probably synclinal, although the only indication of a south limb is in northward-dipping beds in a single exposure in an old coal prospect north of the highway. Synclines have been recognized in the east end of Castle Mountain. just north of Chickaloon, and on Coal Creek. Little is known of the structure of intervening areas, but the few observed outcrops indicate that it is complex.

Creek probably is also followed by a fault.

COAL

The chief mineral resource known to be present in

significant quantity in the lower Matanuska Valley is bituminous coal, which is being mined in the Wishbone Hill and Knob Creek areas and has been extensively explored by both surface and underground methods in the Chickaloon district. A single small strip mine was being operated in the Chickaloon district in 1960. As detailed reports on both the Wishbone Hill and Chickaloon districts have been published (Barnes and Payne, 1956; Capps, 1927), the present study was directed mainly toward determining whether other parts of the area underlain by the Chickaloon formation might contain valuable coal deposits. To accomplish this purpose the writer re-examined previously mapped areas of coalbearing rocks on Young Creek and the Kings River and also extended detailed mapping to areas of Chickaloon rocks in the Little Granite Creek basin, along the south base of Arkose Ridge, and south of the Matanuska River between Wolverine Creek and Kings Mountain. The coal occurrences on Young Creek and the Kings River were found to be of too small extent to warrant detailed examination, and the Chickaloon strata south of Arkose Ridge contain only scattered thin stringers of coal. In the belt of Tertiary rocks south of the Matanuska River the only evidence of coal consisted of a few thin coaly lenses on Wolverine Creek, a dirty coal bed containing a few inches of clean coal opposite the mouth of Little Granite Creek, and a 2-foot bed of bright coal exposed for a short distance in the west bank of Carpenter Creek about $l^{\frac{1}{2}}$ miles above its mouth. An area of about 4 square miles east of lower Granite Creek, including the Little Granite Creek basin and extending eastward to the mouth of Young Creek, is probably all underlain by coal-bearing rocks, although much of the area is covered by thick Quaternary deposits. Exposures along lower Young Creek contain only a few thin traces of coal, but shallow trenching in the western part of this area is reported to have indicated the presence of coal beds several feet thick. The principal coal resources of the Matanuska coal field are in the Wishbone Hill district, in which the estimated remaining reserves, corrected to January 1, 1960, are about 100 million tons (Barnes and Payne, 1956, p. 83). In the adjoining Knob Creek area data are insufficient for reliable reserve estimates, but minable reserves probably amount to several million tons. In the Chickaloon district complex structure, lack of continuity of coal beds, and widespread igneous intrusions probably combine to make most of the coal unminable, although it is possible that locally conditions are more favorable and substantial reserves of minable coal are present.

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The Little Granite Creek area may contain coal beds of

minable thickness and quality, but this can be deter-

evidence of minable coal deposits was found in the other

mined only by extensive subsurface prospecting. No

areas mapped or re-examined in 1960.

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Base from U.S. Geological Survey topographic topographic maps, 1951-52.

Topography of triangular area southeast of Kings Mountain from

enlargement of Anchorage quadrangle map (1:250,000)

nodified by inspection of aerial photographs