The McHugh Complex of South-Central Alaska

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CONTRIBUTIONS TO STRATIGRAPHY

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By SANDRA H. B. CLARK

ABSTRACT

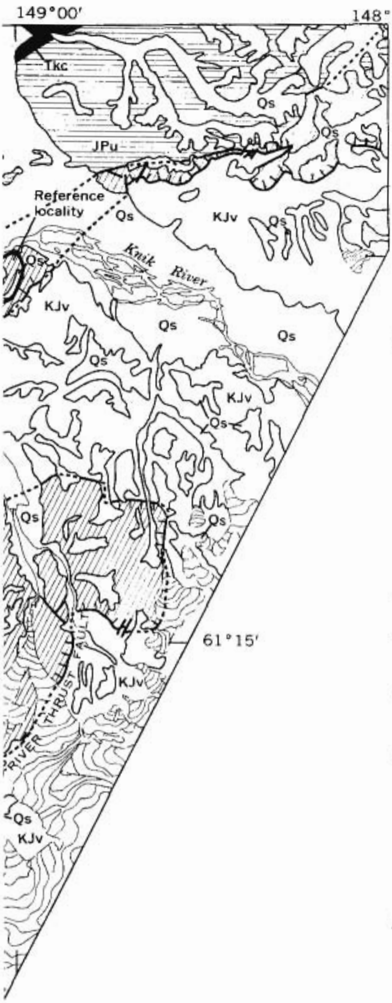
The name McMugh Complex is herein introduced for a heterogeneous assemblage of weakly metamorphosed clastic and volcanic rocks that are well exposed along the northwest flank of the Chugach Mountains near Anchorage, Alaska. Two localities are designated: The type locality along the Seward Highway east and west of McHugh Creek and the reference locality between a bridge across the Knik River on the Glenn Highway and the Pioneer Peak area. The McHugh Complex consists of two lithologically distinct but chaotically juxtaposed rock sequence with irregular outcrop patterns—a metaclastic sequence and a metavolcanic sequence. The metaclastic rocks, which make up the bulk of the complex, are predominantly weakly metamorphosed siltstone, graywacke, arkose, and conglomeratic sandstone. The metavolcanic rocks include massive and pillow greenstones, basaltic in composition and texture, associated with radiolarian metachert cherty argillite, and argillite. Small amounts of ultramafic rocks and marble occur locally. The age of the McHugh Complex is thought to be Late Jurassic and (or) Cretaceous.

Metamorphic minerals are indicative of zeolite to prehnite-pumpellyite facies metamorphism. Bedding is rarely preserved; predominant structures are pervasive shear fractures. A melangelike deformation is characteristic of parts of the complex. The metaclastic sequence is thought to have been derived from a Jurassic continental magmatic arc to the north and west. The metavolcanic sequence is thought to represent ocean floor accumulations that may have been tectonically juxtaposed and mixed with the clastic sequence.

INTRODUCTION

The name McHugh Complex is herein introduced for a heterogeneous assemblage of weakly metamorphosed metaclastic and metavolcanic rocks that are well exposed along the northwest flank of the Chugach Mountains in the Anchorage area (fig. 1). Capps (1916) and Park (1933) informally called the western part of the complex, that is exposed between Potter, Indian, and Eklutna, "undifferentiated metamorphic rocks," and the eastern part, that

FIGURE 1.—Generalized distribution of the McHugh Complex



EXPLANATION

Qs — Surficial deposits* — QUATERNARY

Tkc — Kenai and Chickaloon Formations — *Paleocene to Oligocene* — TERTIARY

KJv — Valdez(?) Group — JURASSIC(?) AND CRETACEOUS

McHugh Complex — *Upper Jurassic and (or) Cretaceous* — JURASSIC AND (OR) CRETACEOUS

JPu — Undifferentiated rocks — PERMIAN AND PERMIAN(?) TO JURASSIC

Plutonic and greenschist to amphibolite facies metamorphic rocks. Includes two ophiolitic ultramafic complexes and plutonic rocks that may be as young as Tertiary

Contact, approximately located

Fault, approximately located; dotted where concealed

Thrust fault, approximately located; short dashes on upper plate; dotted where concealed

\+ Locality of sample dated by potassium-argon method

(Small felsic to intermediate intrusive bodies are present but not shown)

* Most contacts between bedrock and surficial deposits are generalized from maps by H.R. Schmoll and Ernest Dobrovolny of the U.S. Geological Survey (1971)

in the western Chugach Mountains near Anchorage, Alaska.

is exposed from the Girdwood district north to the Knik River, "volcanic tuffs." They considered the "undifferentiated metamorphic rocks" to be an early Mesozoic or Paleozoic unit lying unconformably below the Valdez (?) Group. Park (1933), in accordance with Capps' (1916) observations, showed that, in the Girdwood district, the "volcanic tuffs" discordantly overlie Cretaceous sedimentary rocks. Both Capps and Park interpreted the contact to be an unconformity. Capps later (1940) included the "undifferentiated metamorphic rocks" with the Jurassic Talkeetna Formation and showed "greenstone tuff" (the same unit as the "volcanic tuffs") as a younger unit tentatively assigned to the Upper Cretaceous.

Recent mapping of the western Chugach Mountains in the Anchorage area has shown that rocks of the unit described by Park and Capps as "undifferentiated metamorphic rocks" as well as the "volcanic" or "greenstone tuffs" overlie metasedimentary rocks of Jurassic (?) and Cretaceous age. The contact is everywhere a fault, in some places a high-angle, sharply discordant structure, more commonly a low-angle structure that is parallel or only slightly discordant to bedding and (or) cleavage in rocks above and below. The rocks divided by Capps (1940) into two map units are very similar in metamorphic grade and lithology as well as in their relation to the Jurassic (?) and Cretaceous metasedimentary rocks. The two units have, therefore, been mapped as a single complex by Clark and Bartsch (1971a, 1971b) and Clark (1972).

Recent work has shown that these rocks are younger than and lithologically different from the Lower Jurassic Talkeetna Formation described by Barnes (1962) in the Matanuska Valley area.

McHUGH COMPLEX

The McHugh Complex is here named for its type locality; exposures are easily accessible along the Seward Highway and in the mountains southeast and northwest of McHugh Creek (fig. 1). Because the locality contains a greater percentage of metavolcanic rocks and metaconglomeratic sandstones than most of the complex, a second locality, considered a reference locality, is designated in the area between a bridge across the Knik River on the Glenn Highway and the Pioneer Peak area (fig. 1).

The McHugh Complex characteristically forms high jagged ridges and peaks. Helicopter landing sites are scarce, and much of the area could not be traversed at the time of the field study. Except for more accessible areas near the range front and along the Seward Highway, field observation stations are sparse.

The aerial extent of outcrops of the McHugh Complex is not yet known. The unit has been traced through the Anchorage C–6 and C–5 quadrangles north of the Knik River (fig. 1) and into the Anchorage C–4 quadrangle east of the border of the area mapped (fig. 1). South of Turnagain Arm, the McHugh Complex crops out in the mountains west of Hope. Rocks that are similar to the McHugh Complex in lithology, style of deformation, and setting crop out on the southwestern Kenai Peninsula east of Seldovia (fig. 1). These rocks were mapped by Martin, Johnson, and Grant (1915) as a unit of "graywacke and slate with some chert, limestone and basic igneous material" and described by them as "slates and graywackes of the Kachemak Bay district." Examination of of outcrops of this unit along logging roads near and to the north of Jakolof Bay revealed a distinct similarity to the McHugh Complex. Additional mapping is needed to determine if this unit in the Seldovia area can be correlated with the McHugh Complex.

LITHOLOGY

The McHugh Complex consists predominantly of two lithologically distinct but chaotically juxtaposed rock sequences with irregular outcrop patterns: a metaclastic sequence and a metavolcanic sequence. The metaclastic sequence, which makes up the bulk of the complex, is composed predominantly of gray, gray-green, and dark-green weakly metamorphosed clastic rocks that include siltstone, graywacke, arkose, and conglomeratic sandstone. The metavolcanic sequence includes greenstones mostly of basaltic composition and texture, that are commonly associated with radiolarian metachert, cherty argillite, and argillite. Small amounts of ultramafic rocks and marble occur locally in the complex as isolated, discontinuous outcrops or lenticular masses.

Weathered outcrop faces of the metaclastic rocks are generally dark green, and fresh surfaces are generally either gray or dark green. The finer grained metasiltstones are generally dark gray or black in outcrop and on fresh surfaces. The metasandstones and conglomeratic metasandstones are massive rocks that show little or no evidence of bedding in most areas although layers with apparent lateral continuity of several miles have been seen at a distance and on aerial photos. Conglomeratic layers clearly define bedding locally, and at places grading can be seen in the conglomeratic beds. But attempts to trace the conglomeratic layers have been futile; layers a few feet thick have been traced no more than a few feet.

The metaclastic sequence of the McHugh Complex commonly are composed of very immature quartz-poor sedimentary rocks.

Altered plagioclase is commonly the most abundant mineral, and clasts of pyroxene and hornblende are not uncommon. Potassium feldspar, present in some of the metaclastic rocks, is absent in most. Rock fragments are abundant and include volcanic, plutonic, sedimentary, and metamorphic rocks types. The chemical composition and mineralogy of the metaclastic rocks is close to that of quartz diorite or granodiorite. Fine, pervasive shear fractures and a cloudy appearance of feldspar that is due to incipient alteration are characteristic. The amount of matrix varies greatly; much of the matrix was probably produced by shearing and granulation.

Pillow structures are locally preserved in the greenstones; they comprise close-packed pillows, isolated pillows, and isolated pillow breccia. Some of the greenstones are amygdaloidal. Most of the greenstones form massive dark-green or reddish-green outcrops in which original structures are no longer recognizable. The greenstones are altered and metamorphosed, but relict textures typical of basaltic rocks are generally well enough preserved to be recognizable in thin section. The composition of the greenstones is basaltic; plagioclase and clinopyroxene are dominant minerals. Metachert occurs as lenses in a sheared argillitic matrix, as gray rhythmically bedded metachert with thin argillitic interbeds, and as small irregularly shaped bodies of red, green, or gray metachert adjacent to greenstones. In some of the chert, radiolaria can be distinguished as clear rounded areas in the clouded chert matrix; however, central cavities and traces of spines are rarely preserved. The only radiolaria that were well enough preserved to be identified were found in a clast of conglomeratic metasandstone (Clark and Bartsch, 1971b). Very fine grained pervasively sheared black argillite and cherty argillite are commonly associated with the greenstones and chert. In some areas, lenses and very irregularly shaped bodies of greenstone, chert, and metagraywacke are surrounded by a sheared black argillaceous matrix.

Rocks that characterize the metaclastic and metavolcanic sequences of the complex most commonly occur in the association described above. There are exceptions, however. Greenstones occur locally in some areas of predominantly metaclastic rocks, and metaclastic rocks (especially metasiltstone and metasandstone) are present in some of predominantly metavolcanic areas. In the metavolcanic part, chert and cherty argillite sometimes occur where no greenstone has been found, and some greenstone is not associated with chert and cherty argillite.

Conglomeratic metasandstones are very common in the type locality along the Seward Highway and have been seen at many places throughout the unit, but the distribution lacks a recognizable pattern. The relative positions of the metaclastic and the metavolcanic sequences also are inconsistent and commonly differ greatly on adjacent ridges. Greenstone occurs near the fault contact of the unit with the Valdez (?) Group along the Seward Highway and in many other areas. However, greenstones were absent near the contact in almost as many areas as they were found. No pattern has been observed in the distribution of potassium-feldspar-bearing rocks. The lack of consistency in patterns of distribution of rock types is characteristic of the unit.

AGE

Ages have been determined for three rocks from the McHugh Complex. Because of the melangelike style of deformation, the youngest date obtained is critical for establishing the age of the complex. A granitic clast from a metaconglomeratic sandstone (potassium-argon locality, fig. 1) yielded a potassium-argon date on hornblende of 146 $\pm$ 7 million years (M. A. Lanphere and Arthur Grantz, oral commun., 1971). Because granitic rocks in conglomerates commonly give slightly younger ages than the source terrane (Grantz and others, 1963, Detterman and others, 1965), the clast may be slightly older than indicated by the potassium-argon determinations. The most likely source of the granitic clast is the arcuate belt of Jurassic (Reed and Lanphere, 1970) plutonic and volcanic rocks of the southern Alaska Range and Talkeetna Mountains. Because the clastic rocks must be younger than their source terrane, Late Jurassic is considered to be the maximum age of the metaconglomeratic sandstone.

The ages of other rocks in the complex are indicated by fossils. Identifiable radiolarian of typical Mesozoic types (Helen Foreman, Oberlin College, Oberlin, Ohio, written commun., 1970) have been found in a clast from the McHugh Complex. One limestone lens contained fusilinids of late Paleozoic, possibly Pennsylvanian age (Raymond C. Douglass, written commun., 1970). The ages based on fossil evidence and radiometric dating indicate that the rocks included in the complex range from late Paleozoic to Jurassic. Because the age of the complex itself must be younger than any of its components, Late Jurassic is considered the maximum age.

The minimum age of the complex is limited by the beginning of accumulation of the unmetamorphosed nonmarine conglomerates, sandstones, siltstones, and shales in adjacent areas of the Cook Inlet–Susitna Lowlands and the Matanuska Valley. These sedimentary rocks in the Cook Inlet–Susitna Lowlands crop out less than a mile from the McHugh Complex. The age of the nearby sedimentary rocks is Oligocene (Wolfe, 1966; Wolfe and others, 1966; Wahrhaftig and others, 1969). In the Matanuska Valley, conglomerates of the Chickaloon Formation were deposited in the area of the north flank of the Chugach Mountains beginning in Paleocene time (Barnes, 1962; Wolfe, 1966; Wolfe and others, 1966). The Paleocene Chickaloon Formation continues beneath the surface of the Cook Inlet area as far south as the latitude of Anchorage (C. E. Kirschner, oral commun., 1971). It is therefore considered very unlikely that the McHugh Complex could be Tertiary. On the basis of information available, the age is considered to be Late Jurassic and (or) Cretaceous.

METAMORPHISM

Metamorphic assemblages of prehnite-pumpellyite facies occur throughout most of the McHugh Complex. The most common and easily recognized of these minerals, in both the metasedimentary and metavolcanic rocks, is prehnite. In outcrop, prehnite occurs in distinctive short discontinuous veinlets that are common in the rocks. Pumpellyite is well developed in metabasalts and in some metaclastic rocks from widely-scattered localities, but it is not so common as prehnite. Laumontite and other zeolites are conspicuous as veinlets in outcrops near the range front but are absent in most of the complex.

STRUCTURE

The most prominent structural elements in the McHugh Complex are thin pervasive closely spaced shear fractures that characterize rocks in the complex as seen in outcrop, in hand specimen, and in thin section. Two main orientations appear to be most persistent; older steeply dipping shear fractures are approximately parallel to regional trends; younger shear fractures are nearly horizontal. Many other orientations can be seen in most outcrops, but a somewhat consistent pattern has been deciphered in these two. Bedding is not recognizable or barely recognizable in most outcrops. In most areas where bedding is preserved, it cannot be traced for more than a few feet. Because small folds can only be seen locally, the importance of folding in the unit is not known.

A melangelike structure is visible in several areas on outcrop scale. Irregular detached remnants of beds and lenses occur in a fine-grained, pervasively sheared matrix in many outcrops of the metavolcanic part of the complex. In the massive metaclastic rocks, melangelike structures are not apparent in outcrop, but the pervasive shearing suggests possible melangelike deformation. On a larger scale, mapped sequences of the predominantly metaclastic rocks and predominantly metavolcanic rocks generally cannot be traced from one ridge to the next. In areas where the two main types of rocks in the unit were differentiated, the pattern is that of chaotically mixed fault-bounded blocks. In some areas, an apparent continuity of metaclastic layers for several miles, as seen on aerial photos and cliff faces, suggests that parts of the unit may not be strongly disrupted.

DEPOSITIONAL ENVIRONMENTS

The McHugh Complex is interpreted to be predominantly a mixture of two distinct rock sequences, metaclastic and metavolcanic, that formed in different environments. Mixing was accomplished at least partly, and possibly entirely, tectonically.

The metaclastic rocks, predominantly volcanic clasts, also include clasts of sedimentary, plutonic, and metamorphic rocks. The immaturity of the sediments and the angularity of the clasts indicate that the clasts of the metaclastic rocks must have been rapidly eroded and transported. The most likely source area for these rocks is an older arcuate mountain belt (Jones and others, 1970) to the north and west that includes the Alaska Range and the Talkeetna and Wrangell Mountains and extends into the northern part of the Chugach Mountains (Clark, 1972). Here during Jurassic time plutons were emplaced (Reed and Lanphere, 1970) and there was andesitic volcanism (Capps, 1927, Barnes, 1962) in parts of this older belt. The only known occurrence of blueschist is near Seldovia (Martin and others, 1915) in a southern extension of the older arcuate belt. That blueschist is similar to a clast of blueschist that was found in one metaconglomeratic sandstone from the McHugh Complex. Because of the similarity of clasts in the two areas, as well as their proximity to each other, it is thought that debris from the active Jurassic continental magmatic arc was shed rapidly into a basin to the south and east to form the metaclastic part of the McHugh Complex.

The metavolcanic part of the complex is indicative of an environment of deposition that contrasts sharply with that of the metaclastic part. The association of tholeiitic pillow basalt, fine-grained sediments, and bedded cherts suggests deposition in a quiet marine environment that was not receiving large amounts of clastic material. The mixing of the oceanic metavolcanic sequences of the McHugh Complex with the metaclastic sequences derived from a continental magmatic arc could be explained by convergence of an oceanic plate and a continental plate. Changes in the environment of deposition followed by tectonic mixing is a second possible explanation.

RELATIONS TO ADJACENT ROCK UNITS

The McHugh Complex is separated from rocks to the northwest and southeast by major faults. In the southeast most of the contact between the rocks of the McHugh Complex and the flysch deposits of the Valdez (?) Group is the Eagle River thrust fault, a low- to moderate-angle fault that thrusts the McHugh Complex over the Valdez (?) Group. In some places the contact is cut by high-angle faults, or is a high-angle fault.

Metamorphic and plutonic rocks northwest of the McHugh Complex that range in age from Permian to Jurassic are part of the older terrane that probably was the source area of the clastic rocks in the McHugh Complex. The older terrane is juxtaposed with the McHugh Complex by the Knik fault, a complex structure that is thought to be a high-angle fault or zone of faulting along most of its length.

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