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Reconnaissance Bedrock Geology of the Southeastern Part of the Kenai Quadrangle, Alaska

By Dwight C. Bradley *and* Frederic H. Wilson

Abstract

We present a new reconnaissance geologic map of the southeastern part of the Kenai quadrangle that improves on previously published maps. Melange of the McHugh Complex is now known to form a continuous strike belt that can be traced from the Seldovia to the Valdez quadrangle; a problematic 75-km-long gap in the McHugh Complex in the Kenai and Seldovia quadrangles does not exist. An Eocene near-trench pluton underlies a range of nunataks in Harding Icefield.

Introduction

The bedrock geology of the southeastern part of the Kenai 1:250,000-scale quadrangle (fig. 1) has never been mapped systematically. The map of the Cook Inlet region by Magoon and others (1976) shows geology in this corner of the Kenai quadrangle, but their compilation was derived from two inadequate sources: Karlstrom (1964) and Martin and others (1915). The map of Quaternary deposits in the Kenai lowland by Karlstrom (1964) also shows the distribution of bedrock in northwestern foothills of the Kenai Mountains; however, his investigations of the bedrock were incidental and, in light of knowledge gained since the 1960's, his unit assignments need revision. For the area of high mountains and icefields to the southeast, Magoon and others (1976) cited Martin and others (1915) as the primary source; this area, however, was left mostly blank on the Martin map. It is hardly surprising, therefore, that the compilation map of Magoon and others (1976) should show a problematic map pattern in the Seldovia and Kenai quadrangles: a ~75-km gap in the outcrop belt of a regionally extensive melange unit—the McHugh Complex.

Specific problems with the geologic map of the Kenai quadrangle became apparent during recent mapping in the Seldovia quadrangle to the south (Bradley and others, 1999; Kusky, Bradley, Haeussler, and Karl, 1997). In the northern Seldovia quadrangle and southeastern Kenai quadrangle, Magoon and others (1976) showed the Upper Cretaceous Valdez Group as the only bedrock unit. New mapping in the Seldovia quadrangle revealed the presence of a large granodiorite batholith, a wide belt of melange assigned to the Permian to Cretaceous McHugh Complex, and a correspondingly smaller area underlain by the Valdez Group. The granodiorite and melange were traced to the northern edge of the Seldovia quadrangle. It was clear from that point that comparable revisions would also be needed in the adjacent Kenai quadrangle.

In the present study, we traced the boundary between Valdez Group and McHugh Complex about 75 km across the southeastern corner of the Kenai quadrangle and better delimited the northern extent of the granodiorite (fig. 2). The mapping was done in one day with a helicopter in September 1998. The U.S. Geological Survey has no immediate plans to systematically map the bedrock geology of the Kenai quadrangle, and thus we report our reconnaissance observations here.

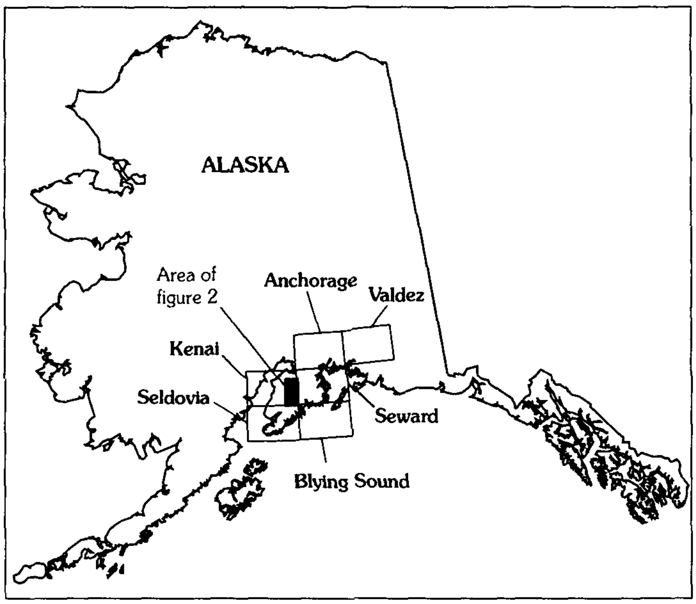

Figure 1. Map of Alaska showing area of figure 2 and 1:250,000-scale quadrangles referred to in text.

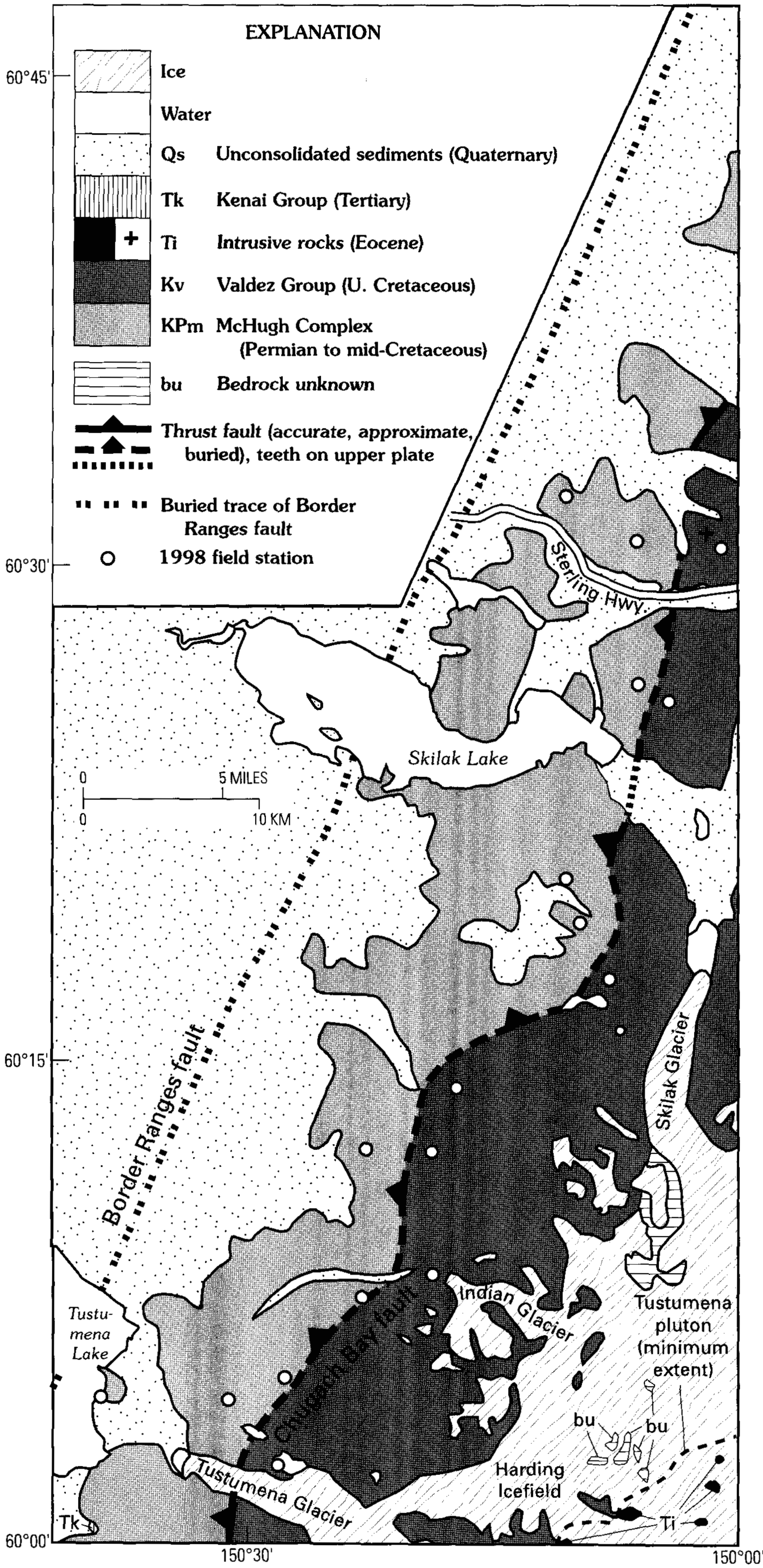

Figure 2. Bedrock geologic map on southeastern Kenai quadrangle, Alaska. Bedrock geology is based on this study; distribution of Quaternary sediments is taken, in part, from Magoon and others (1976) and Karlstrom (1964).

Bedrock Units

McHugh Complex

Rocks in the study area assigned to the McHugh Complex (Clark, 1973) include sandstone, greenstone, chert, argillite, and melange. The sandstone is typically medium- to coarse-grained graywacke, rich in matrix, containing abundant chert and volcanic lithic fragments and somewhat less abundant quartz and feldspar. Owing to an absence of interbedded fine-grained rocks, or of amalgamation surfaces within sandstone bodies, bedding was not observed. Based on the size of outcrops consisting wholly of sandstone, beds are probably many tens of meters thick. Contorted veinlets of prehnite—a hallmark of McHugh Complex sandstone in the Seldovia and Anchorage quadrangles—are present in abundance. Greenstone was observed at a single outcrop and consists of altered, dark green, fine-grained basalt containing plagioclase laths that are visible under the hand lens. Several types, or "facies," of melange were observed; common to all is a phacoidally cleaved matrix of typically dark-gray argillite, which encloses fragments of various other rock types. One melange facies consists largely of matrix, and the "blocks" are dismembered beds of fine-grained, thin-bedded siliceous rocks and (or) siltstone that differ in competence only slightly from the matrix. A second facies contains a more diverse assemblage of blocks that are much more competent than the matrix, including sandstone, greenstone, chert, and limestone; this facies corresponds to what Bradley and Kusky (1992) referred to as mesoscale melange in the Seldovia quadrangle. No effort was made in the present reconnaissance study to map subunits of sandstone, chert, and basalt within the McHugh Complex, but this has proven to be possible in the Seldovia and Valdez quadrangles (Bradley and others, 1999; Winkler and others, 1980) (fig. 1).

Because no fossils have been recovered from the McHugh Complex in the Kenai quadrangle, its age must be extrapolated from areas along strike, particularly in the Seldovia quadrangle (see summary of older literature in Bradley and others, 1997). The best age control is from radiolarian cherts, which range in age from Ladinian (Middle Triassic) to Albian-Aptian (mid-Cretaceous). In the Seldovia quadrangle, chert depositionally overlies pillow basalt in several places; radiolaria from these particular chert sections are of Ladinian to Albian age, suggesting similar or slightly older ages for the pillow basalt. At one location in the Seldovia quadrangle, a Pleinsbachian (Early Jurassic) age is inferred for sandstone based on radiolaria of that age from chert immediately below sandstone (Bradley and others, 1997). A massive graywacke unit in Seldovia quadrangle is crosscut by a dike of basaltic andesite, which has a $^{40}Ar/^{39}Ar$ hornblende age of 115±2 Ma (Bradley and others, this volume). Limestone blocks within melange have yielded Permian fusilinids (Stevens and others, 1997) and conodonts (A. Harris, written commun., 1994). The age of McHugh protoliths thus spans Permian to mid-Cretaceous time; the age of melange formation is not well established but is likely to have spanned the Early Jurassic to mid-Cretaceous (Bradley and others, 1997).

Valdez Group

The Valdez Group, where we observed it, consists of medium-, thin-, and thick-bedded sandstone, siltstone, and slate, interpreted as turbidites. The medium-bedded turbidites consist of sandstone in graded beds a few centimeters to about 1 m thick. Interbedded slate is present in subordinate amounts. Thin-bedded turbidites consist of thinly interbedded slate and fine sandstone to siltstone, in roughly equal proportions. Bedding thicknesses range from less than one to a few centimeters. The thick-bedded turbidites consist of medium- to coarse-grained sandstone in beds ranging in thickness from a few meters to tens of meters. These beds have graded and (or) erosive bases and are rich in shale (now slate) rip-ups. The sandstone is subgraywacke, characterized by markedly less matrix and better sorting than sandstones of the McHugh Complex. Framework grains are predominantly quartz, feldspar, and lithic fragments; chert is rare. No fossils are known from the Valdez Group in the Kenai quadrangle; elsewhere, it has yielded bivalves of Maastrichtian (Late Cretaceous) age (Jones and Clark, 1973; Tysdal and Plafker, 1978).

In the Seldovia quadrangle, Kusky, Bradley, Haeussler, and Karl (1997) delineated a belt of tectonically disrupted Valdez Group. These rocks are informally referred to as the Iceworm melange, after exposures in the area of Iceworm Peak. The melange is readily distinguished from melanges of the McHugh Complex by its monomict clast assemblage: it consists of blocks, boudins, and dismembered beds of Valdez Group sandstone in a phacoidally cleaved matrix of Valdez Group slate. This belt of melange, which lies immediately east of and structurally beneath the McHugh Complex, was traced northward to the southern boundary of the Kenai quadrangle (Bradley and others, 1999; Kusky, Bradley, Haeussler, and Karl, 1997). In the present study, we encountered only one outcrop of tectonically disrupted Valdez Group, at the margin of Tustumena Glacier, on strike with the Iceworm melange mapped in the Seldovia quadrangle. This melange belt may or may not continue northward through the Kenai quadrangle. If it does, the outcrop belt is probably somewhat less than 1 km wide. In the Anchorage quadrangle, an equivalent melange belt, about 1 km in width, has been recognized just below the Eagle River fault along Turnagain Arm (Kusky, Bradley, and Haeussler, 1997).

Kenai Group

A small area of coal-bearing semiconsolidated silt, sand, and gravel near the snout of Tustumena Glacier was mapped as the Tertiary Kenai Group by Karsltrom (1964). The age of this outlier of Kenai Group is unknown; in the northern Seldovia quadrangle, comparable strata that flank the McHugh Complex along the mountain front are assigned to the Sterling Formation of Pliocene age (Magoon and others, 1976).

Quaternary Geology

The Quaternary geology of the area was not investigated in the present study, but a few anecdotal observations bear mentioning. Unconsolidated sediments include glacial deposits belonging to various Pleistocene glaciations (Karlstrom, 1964; Reger and Pinney, 1997), and Holocene fluvial, colluvial, and other surficial deposits. Tustumena, Skilak, and Indian glaciers have each receded about 1 km since the most recent 1:63,360-scale topographic maps were published in the early 1980's. The snouts of Tustumena and Skilak Glaciers now face into lakes that are not shown on the topographic maps.

Intrusive Rocks

Nunataks in the extreme southeastern corner of the Kenai quadrangle are mapped as part of the Tustumena granodiorite pluton, a body that was unknown before the recently completed mapping in the Seldovia quadrangle (Bradley and others, 1999). The nunataks have not been visited, but in 1992 they were observed through binoculars from the northern edge of the Seldovia quadrangle and were seen to be made of granitic rocks. In the Seldovia quadrangle, the Tustumena pluton consists of medium- and coarse-grained, weakly foliated to unfoliated biotite granodiorite. It has yielded a $^{40}Ar/^{39}Ar$ biotite plateau age of 53.2±1.1 Ma (D. Lux, University of Maine, written commun., 1994; Bradley and others, this volume).

We located a small plug of fine-grained, light-gray dacite near the summit of Round Mountain, north of the Sterling Highway ("+" symbol in fig. 2). Several dacite dikes occur in the area a few kilometers west of this plug.

Structure and Metamorphism

Two principal tectonic elements make up the map area (fig. 2): Cook Inlet basin and the Chugach terrane. The Kenai lowland, in the northwestern part of the map area (fig. 2), is part of the Cook Inlet basin, the active forearc basin of the Aleutian arc. The lowlands are underlain by Tertiary sedimentary rocks of the Kenai Group, which have gentle dips and have not been penetratively deformed, and by a cover of Quaternary glacial and postglacial sediments.

The McHugh Complex and Valdez Group are part of a Mesozoic accretionary wedge—the Chugach terrane—and have been affected by subduction-related deformation and metamorphism. The principal fabric elements—phacoidal cleavage and compositional layering in the McHugh Complex and bedding and cleavage in the Valdez Group—strike north-northeast and dip moderately to steeply both to the northwest and southeast. Regionally, the contact between the McHugh Complex and the Valdez Group is a major west-dipping thrust fault, known as the Eagle River thrust in the Anchorage quadrangle, and as the Chugach Bay thrust in the Seldovia quadrangle (Kusky, Bradley, Haeussler, and Karl, 1997). In the present reconnaissance study, we did not examine the fault zone but have no reason to doubt its presence.

Metamorphism was not investigated in this brief study, but a few observations are warranted. Sandstone of the McHugh Complex is cut by abundant veinlets of prehnite related to low grade regional metamorphism. The Valdez Group appears to have been regionally metamorphosed to chlorite grade. Locally, some of the Valdez Group has been hornfelsed, suggesting the presence of unrecognized Tertiary intrusive rocks, either nearby or at depth.

Summary of New Findings

Our reconnaissance mapping produced the following results: (1) The compilation map of Magoon and others (1976) shows a problematic map pattern that has long defied explanation: a ~75-km gap in the outcrop belt of the McHugh Complex, between the north end of Kachemak Bay in the Seldovia quadrangle and Skilak Lake in the Kenai quadrangle. Our results show that the gap does not exist and that the McHugh Complex is continuous through the Seldovia, Kenai, Seward, and Anchorage quadrangles. The resulting map pattern can be readily interpreted in terms of successive accretion of the McHugh Complex and the Valdez Group at a subduction zone. (2) Our mapping extends the Tustumena pluton at least 5 km northward into the Kenai quadrangle. (3) Three nunataks at the confluence of Indian Glacier and the Harding Icefield were not visited, but we were able to map them as the Valdez Group based on the overwhelming predominance of Valdez Group boulders at the snout of Indian Glacier. Some remote peaks at the edge of and within Harding Icefield remain unmapped; most likely, these areas are underlain by either granodiorite or the Valdez Group.

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