# Stratigraphic Notes, 1994

U.S. GEOLOGICAL SURVEY BULLETIN 2135

*Three short papers present changes in stratigraphic nomenclature in Virginia, Kentucky, and Alaska*

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1995

# CONTENTS

# CONVERSION FACTORS

| Multiply | By | To obtain |
|---|---|---|
| inch (in.) | 2.54 | centimeter |
| foot (ft) | 0.3048 | meter |
| mile (mi) | 1.609 | kilometer |
| centimeter (cm) | 0.3937 | inch |
| meter (m) | 3.281 | foot |
| kilometer (km) | 0.6214 | mile |

# 3. The Coast Mountains Complex of Southeastern Alaska and Adjacent Regions

By David A. Brew,[1] Arthur B. Ford,[1] Glen R. Himmelberg,[1] and James L. Drinkwater[1]

## ABSTRACT

The Cretaceous and Tertiary Coast Mountains Complex is a 1,750-km-long, plutonic-metamorphic entity that extends into Canada both to the northwest and southeast of southeastern Alaska. This entity is part of the discontinuous intrusive-metamorphic system of the western Cordillera that extends from Baja California on the south to the Alaska Peninsula on the northwest.

This note formally names the part of the Coast Mountains Complex in Alaska in accord with accepted procedures and definitions of the North American Commission on Stratigraphic Nomenclature, U.S. Board on Geographic Names, and U.S. Geological Survey. The type area for the lithodemic complex is herein designated as a transect across the Coast Mountains near Juneau, Alaska. Overall, the complex consists of about 70 percent intrusive granitic rocks, most of which are latest Cretaceous to middle Tertiary in age, and most of the remainder consists of metamorphic rocks. A consistent metamorphic-plutonic zonation with four northwest-striking zones characterizes the complex. The protoliths of the metamorphic rocks range from Late Proterozoic to Cretaceous in age and were metamorphosed during several episodes, the most important being Early and Middle Triassic, Early Cretaceous, and latest Cretaceous in age. Most of the intrusive and metamorphic episodes postdate the assembly of the terranes that provide the metamorphic rock protoliths; the accreted lithotectonic terranes are the Nisling, Stikine, and Wrangellia, the Behm Canal structural zone, and the Gravina overlap assemblage. Although the ages of protoliths and intrusive rocks together range from Late Proterozoic to Tertiary, most of the intrusive and metamorphic events occurred in Cretaceous and Tertiary time, and we therefore refer to the complex as Cretaceous and Tertiary in age.

The rocks of the Coast Mountains Complex have been, and currently are being, referred to by several informal names; most are incorrect either geologically or geographically, and the remainder are misleading at best. The formal name Coast Mountains Complex rectifies these problems.

[1] U.S. Geological Survey, Menlo Park, CA 94025–3591.

## INTRODUCTION

The 1,750-km-long complex of intrusive and metamorphic rocks that extends along the west coast of North America from the latitude of Vancouver, British Columbia, Canada, into Alaska west of the 141st meridian is probably the world's largest single plutonic-metamorphic complex (fig. 1). It is the major segment of a still larger, discontinuous plutonic-metamorphic complex that extends south from the Coast Mountains physiographic province of Alaska, the Yukon, and British Columbia, through the western conterminous United States, and south to the southern tip of Mexico's Baja California for a total length of about 8,000 km. Different names, some of which are (in our opinion) inappropriate, inaccurate, or otherwise misleading, have been applied to the Alaska-British Columbia part of the complex. The purpose of this note is to formally name this complex in accordance with the guidelines provided by the North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983). The name we have selected is Coast Mountains Complex. In this note, we record the previous and current conflicting terms applied to this complex, locate the complex in relation to other segments of the overall system, give our rationale for selecting the formal name Coast Mountains Complex, and briefly describe the herein-designated type area at and east of Juneau, Alaska. This complex can be described by using several different sets of criteria; herein, we use the plutonic-metamorphic zonation of Brew and Ford (1984).

## GENERAL LOCATION AND DESCRIPTION

The boundaries of the Coast Mountains Complex as defined here (fig. 2) are, except for minor changes, the same as those defined and outlined by Brew and Ford (1984); the changes are so minor that they are insignificant. The western boundary is either the eastern contact of Gravina overlap assemblage rocks or, where those rocks have been metamorphosed, the western limit of the metamorphic effects. The eastern boundary of the complex is either the eastern limit of the metamorphism associated with the

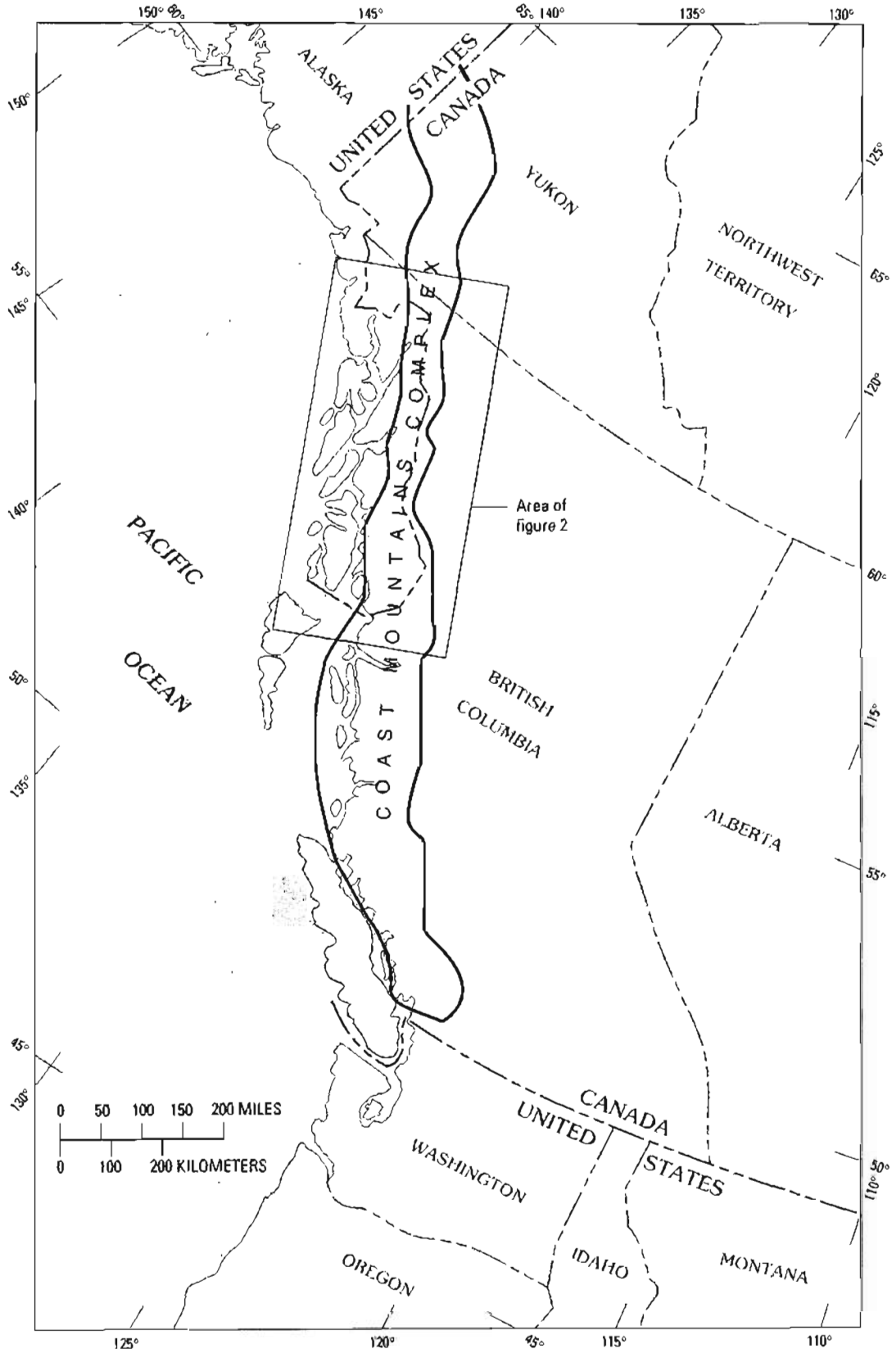
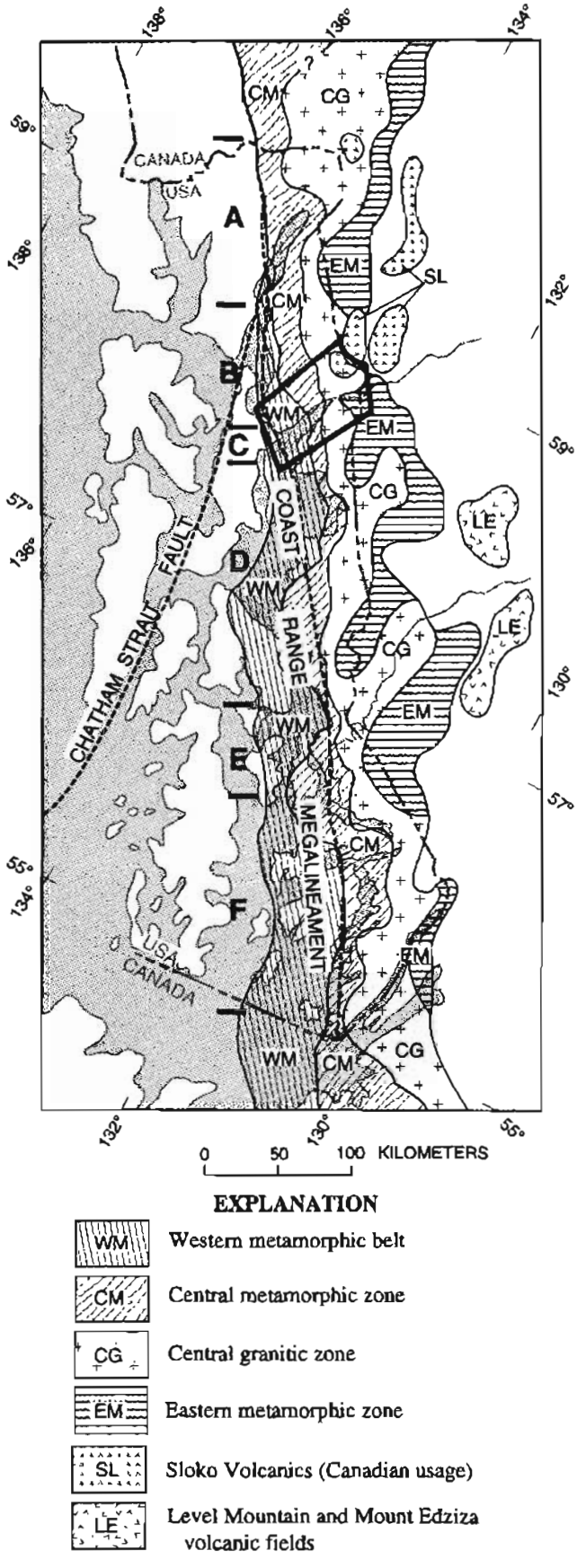



**Figure 1.** Location of Coast Mountains Complex in the United States and Canada. The complex may continue west past the limit of the studied area at the intersection of lat 62° N. with the 141st meridian.




← **Figure 2.** Coast Mountains Complex, southeastern Alaska and adjacent parts of British Columbia, showing approximate boundaries of major belts, zones, and units (from Brew and Ford, 1984). Single capital letters A–F indicate different segments of the complex mentioned in the text. Type area of complex is indicated by heavy outline; Juneau is located under the "M" of "WM" within that outline.

Tertiary plutons or, where Nisling terrane pre-Tertiary metamorphic rocks adjoin the Tertiary intrusions, the eastern contact of those metamorphic rocks.

The Coast Mountains Complex as a whole extends from the latitude of Vancouver, B.C. (about lat 48° N.), to the intersection of lat 62° N. with the 141st meridian, a distance of about 1,750 km. This note focuses on the part of the complex that is in southeastern Alaska, although much of the complex is in Canada. From past discussions with our Canadian colleagues, it appears unlikely to us that they will accept this name for the Canadian portion, however well it may be grounded in the North American Stratigraphic Code. The complex takes its name from the Coast Mountains physiographic province (Holland, 1964), which in southeastern Alaska consists of the Boundary Ranges subprovince (Wahrhaftig, 1965). This province closely follows tidewater on its west to about lat 59°30' N. (fig. 1), where tidewater is left behind and the province is inland of the more prominent Pacific Border Ranges province.

The Coast Mountains Complex can be described in terms of its metamorphic-plutonic zonation (Brew and Ford, 1984), metamorphic belts (Brew and others, 1989, 1992), magmatic belts (Brew and Morrell, 1980, 1983; Brew, 1988, 1994), individual plutons (Drinkwater and others, 1989, 1990, 1992a,b, 1994), and lithotectonic terranes and superterranes (Monger and others, 1982; Brew and Ford, 1994). Rather than reiterate all of these aspects in detail here, we refer the reader to the above papers; the following paragraphs summarize only the overall metamorphic-plutonic zonation and provide some detail as to the occurrence of plutons and batholiths in the complex.

The Coast Mountains Complex in southeastern Alaska and adjacent parts of British Columbia consists of four major belts or zones, shown in figure 2 from west to east: western metamorphic belt, central metamorphic zone, central granitic zone, and eastern metamorphic zone. Figure 2 also shows the distribution of the Sloko Volcanics (Canadian usage) and the Level Mountain and Mount Edziza volcanic fields; these are shown because they are the volcanic expression, in part, of the plutonism recorded in the complex.

One of the main reasons for describing this zonation was to establish the close linkage between the rocks of the western metamorphic belt and the other parts of the complex. Brew and Ford (1978), as well as others previously, excluded those rocks from the rest of the complex, but their

origin and evolution are now known to be inextricably linked to those of the other parts.

The Coast Mountains Complex consists almost entirely of metamorphic and plutonic rocks, although it includes some small outliers of young volcanic rocks (fig. 2) and at least one area of very low grade metamorphic rocks within the central granitic zone (Brew and others, 1985). The extensive snow and ice that mantle it discourage attempts at areal measurements, and there are no rigorous calculations of the proportions of intrusive and metamorphic rocks available. Subjective estimates of the ratio of plutonic rocks to metamorphic rocks for six southeastern Alaska segments (fig. 2), in which orthogneisses are included with the plutonic rather than with metamorphic rocks, are as follows:

| Segment labeled on fig. 2 | Ratio of plutonic to metamorphic rocks |
|---|---|
| A (Alaska-British Columbia boundary south to Berners Bay) | 7:3 |
| B (Berners Bay to Taku Inlet) | 6:4 |
| C (Taku Inlet to Whiting River) | 5:5 |
| D (Whiting River to Stikine River) | 8:2 |
| E (Stikine River to Bradfield River) | 6:4 |
| F (Bradfield River to Portland Canal) | 7:3 |
| Average | 7:3 |

As described below for the different metamorphic-plutonic zones, the ages of protoliths and intrusive rocks in the Coast Mountains Complex range from Late Proterozoic to Tertiary. However, most of the intrusive and metamorphic events occurred in Cretaceous and Tertiary time, and we therefore refer to the complex as Cretaceous and Tertiary in age.

The western metamorphic belt consists mostly of progressively metamorphosed (higher grade to the northeast) medium- to high-pressure and medium- to high-temperature pelitic and amphibolitic schists. The schists near Juneau have been described in detail by Himmelberg and others (1991, 1994a,b), and the lower grade rocks that are adjacent to the west were described by Himmelberg and others (1995). Overall, the protolith ages for the belt range from Permian and older to Late Cretaceous. Scattered Cretaceous and Tertiary epizonal to mesozonal granitic to ultramafic bodies occur within the western metamorphic belt (Brew and Morrell, 1980, 1983; Brew and Ford, 1984; Brew, 1988, 1994). As noted above, the western boundary of the belt and of the Coast Mountains Complex is either the eastern contact of Gravina overlap assemblage rocks or, where those rocks have been metamorphosed, the western limit of the metamorphic effects.

The central metamorphic zone consists mostly of synkinematic to postkinematic mesozonal to epizonal granitic bodies, mixed with intermediate- to high-temperature and high-pressure schists, gneisses, and some migmatites (Brew and Ford, 1984, 1985; Brew and others, 1984; Karl and Brew, 1984). The ages of the protoliths of the rocks in the zone are uncertain, but most may be Late Proterozoic to Paleozoic (Gehrels and others, 1990; Brew and others, 1994) and belong to the Nisling terrane. The granitic rocks range in age from Paleozoic(?) to Tertiary, with the most conspicuous single map unit being the latest Cretaceous and Paleocene Great tonalite sill (Brew and Ford, 1981; Brew, 1988, 1994; Ingram and Hutton, 1994).

The central granitic zone consists mostly of crosscutting epizonal to mesozonal unfoliated granodioritic to granitic plutons of middle to late Tertiary age (Brew, 1988, 1994), with minor screens and pendants of metamorphic rocks like those in the central metamorphic zone and minor migmatites (Brew and Ford, 1984). The Sloko Volcanics (Souther, 1971) (fig. 2) are roughly coeval with the middle Tertiary plutonic rocks. Field mapping (Brew and others, 1984; Brew and Ford, 1985; Berg and others, 1988) and detailed studies (Drinkwater and others, 1992a,b) indicate that many (and perhaps most) of the individual granitic bodies in this zone are of batholithic dimensions (Bates and Jackson, 1987).

The eastern metamorphic zone consists mostly of low- to high-temperature, low-pressure hornfels with scattered epizonal granitic bodies (Brew and Ford, 1984). This zone is exposed mostly in British Columbia and includes some intermediate- to high-temperature and high-pressure schists, gneisses, and marbles that have the same protoliths as described for the central metamorphic zone and probably belong to the Nisling terrane. Other protoliths include Permian to Upper Triassic rocks like those extending to the east beyond the Coast Mountains Complex. As noted above, the eastern boundary of this zone and of the complex is either the eastern limit of the metamorphism associated with the Tertiary plutons or, where Nisling terrane pre-Tertiary metamorphic rocks adjoin the Tertiary intrusions, the eastern contact of those metamorphic rocks.

## PREVIOUS AND CURRENT INFORMAL NOMENCLATURE

Many different informal terms have been, and are currently being, used to describe the geologic entity that we here formally name the Coast Mountains Complex. In our opinion, some of the terms are inaccurate, some are misleading, and the multitude of terms itself has led to confusion. The informal terms used previously include Coast batholith, Coast batholithic complex, Coast crystalline belt, Coast Mountain belt, Coast Plutonic Complex, Coast plutonic-metamorphic complex, Coast Range batholith, Coast Range batholithic complex, and Coast Range plutonic complex. The shortcomings of most of these terms are discussed in the following section.

In their pioneering study based on fieldwork done about 70 years ago, Buddington and Chapin (1929) used the term "Coast Range batholith" in their text and on their maps to indicate the intrusive granitic rocks (Buddington, 1927), gneisses, and other rocks of what is now called the Great tonalite sill and on to the northeast of it as far as the international boundary. Buddington and Chapin (1929) used the terms "Wrangell-Revillagigedo belt of metamorphic rocks" or "Wrangell-Revillagigedo metamorphic belt" for the "composite belt of sedimentary and intrusive rocks" or "metamorphic complex belt" that bordered their Coast Range batholith on the southwest. Their Coast Range batholith corresponds to the central metamorphic and central granitic zones of the Coast Mountains Complex as defined here, and their Wrangell-Revillagigedo belt of metamorphic rocks corresponds more or less to the western metamorphic belt of the complex.

Douglas and others (1970) may have been the first to use the term "Coast plutonic complex," which they defined as a belt of crystalline rocks or a complex composed dominantly of foliated and unfoliated granitic rocks with a gneiss-migmatite core that contained some large areas of metamorphic rocks. They specifically noted (p. 427) that "An irregular belt of narrow, elongate, steep-walled roof pendants of metasedimentary rocks stretches southeastward from within the Wrangell-Revillagigedo gneiss belt on the west side of the complex in southeastern Alaska, to near the eastern side, near Bella Coola." The sketch map of Douglas and others (1970, p. 422) shows the western limit of their Coast plutonic complex about where Buddington and Chapin (1929) placed the eastern edge of their Wrangell-Revillagigedo belt, but it seems clear that Douglas and others (1970) and Roddick and Hutchison (1974) intended to include the rocks of the Wrangell-Revillagigedo belt in their Coast plutonic complex. This inclusion agrees with our definition of the Coast Mountains Complex. At about the same time, Forbes and Engels (1970) were using the term "Coast Range batholith and related rocks" for the complex.

Brew and Ford (1978) summarized how the U.S. Geological Survey had been handling the terminology for the preceding two decades or so in their footnote on page 1764: "The [informal] term Coast Range batholithic complex is used here to denote the granitic and gneissic rocks of the Coast Range as well as any enclosed schists, marbles, etc. This usage specifically excludes parts of the schist terrane of the Wrangell-Revillagigedo metamorphic belt (Buddington and Chapin, 1929) that adjoins the gneisses and granitic rocks on the southwest."

Brew and Ford (1984) were the first to use the informal term "Coast plutonic-metamorphic complex" for all of the rocks included in both Buddington and Chapin's (1929) Coast Range batholith and their Wrangell-Revillagigedo belt. Brew and others (1991, 1992) continued this informal use during the time that other workers (Barker and Arth, 1984; Arth and others, 1988; Gehrels and others, 1991) continued to refer to the entire complex informally as a batholith. More recently, Brew and Ford (1993, 1994) realized that the term "Coast," when used alone (as they had used it), was inappropriate, as it was not a valid geographic-physiographic name, and started using the informal term "Coast Mountains plutonic-metamorphic complex" instead.

## RATIONALE FOR SELECTION OF FORMAL NAME

As noted above, the Coast Mountains Complex includes metamorphic rocks and plutonic rocks of different ages and types. Many of the plutons are of batholithic dimensions, and most have been grouped into chronometric and modal-compositional belts (Brew and Morrell, 1980, 1983; Brew, 1988, 1994). After studying the rocks of the complex and dealing with the multitude of informal names for about 30 years, we have decided to here formally name this world-class geologic entity the Coast Mountains Complex. This note informs others of the problems involved and our reasoning in this action.

The North American Stratigraphic Code (North American Commission on Stratigraphic Nomenclature, 1983, p. 861, article 37) defines the lithodemic unit term "complex" as "An assemblage or mixture of rocks of *two or more genetic classes*, i.e., igneous, sedimentary, or metamorphic ... ." Prior to the 1983 version of the code, the term "complex" had been used for a variety of geologic entities that do not fit the 1983 definition; for example, Stillwater Complex, Shoo Fly Complex, Franciscan Complex, Valdez Complex. The Coast Mountains Complex being named in this note may be the first formal use of the term "complex" in the United States to follow the 1983 definition.

Two of the authors of this note made a serious effort (Brew and Ford, 1989, 1990) to amend the code to exclude the lithodemic term "complex" from formal stratigraphic nomenclature, but that proposed amendment was defeated by a formal vote of the North American Commission on Stratigraphic Nomenclature. Because the geologic entity we study is truly a complex as defined by the 1983 code, we are formally naming it herein as the Coast Mountains Complex.

Other large plutonic-metamorphic complexes in the world are called "batholiths"; for example, the Boulder batholith of Idaho, the Sierra Nevada batholith of California and Nevada, the Peninsular Ranges batholith of southern California and northern Baja California, and the Cordilleran batholith of western South America. The same terms have been applied consistently and without variation to these geologic entities for many years, even though each actually consists of more than one "batholith" as defined by Bates and Jackson (1987, p. 59). Many informal terms, including the word "batholith," have been applied to the rocks that we call the Coast Mountains Complex, but we wish to follow

the 1983 code, which clearly indicates that "complex" is the proper term for the entity we study.

Terms cited in the above section on "Previous and Current Informal Nomenclature" that incorporate the words "batholith," "Coast" [used alone], "Coast Range," and "belt" are inappropriate because these are not approved geographic-physiographic names. Orth (1967, p. 227) specifically pointed out that the name "Coast Range" is "frequently misapplied to the Coast Mountains." Informal terms including the word "belt" are also inappropriate because "belt" is not defined by the 1983 code.

Names using "complex" with the implication that it is solely a plutonic complex violate the definition in the 1983 code. Some of our colleagues consider the term "plutonic" to include medium- to high-grade metamorphic, as well as intrusive, rocks; Bates and Jackson (1987, p. 513) defined the term as "Pertaining to igneous rocks formed at great depth" or "Pertaining to rocks formed by any process at great depth." We use the term "plutonic" here in the sense of being associated with plutons, meaning discrete bodies of intrusive igneous rock.

## LOCATION AND DESCRIPTION OF TYPE AREA

On the basis of our studies along the length of the Coast Mountains Complex in southeastern Alaska, we here designate a broad (about 40 km wide) transect extending for about 80 km from Douglas Island on the south-southwest to the Alaska-British Columbia boundary on the north-northeast as the type area of the Coast Mountains Complex (fig. 2). This transect contains all of the various belts, zones, terranes, and other features that occur anywhere in the complex. It is the site of the greatest amount of detailed mapping in the complex, and the pertinent chronometric and compositional units present here have been described adequately and also have been correlated lithologically and temporally with their lateral equivalents on strike throughout the length of the complex in southeastern Alaska.

The transect is contained within the regional geologic map of Brew and Ford (1985), and a large part is also within the detailed geologic maps of Ford and Brew (1973, 1977b), Brew and Ford (1977), and D.A. Brew and A.B. Ford (unpub. data). From south-southwest to north-northeast, it is made up of these major units and structures, listed with their lithotectonic terrane assignments:

(1) low-pressure, low-temperature, intermediate-composition metavolcanic and some metapelitic sedimentary rocks of the Douglas Island Volcanics of the Stephens Passage Group of the Gravina overlap assemblage (Lathram and others, 1965; Berg and others, 1972; Ford and Brew, 1988; Himmelberg and others, 1995);

(2) the Coast Range megalineament as defined by Brew and Ford (1978), which is here the high-angle Gastineau Channel fault (Ford and Brew, 1973);

(3) low- to medium-pressure, low- to medium-temperature, mafic- to intermediate-composition metavolcanic and some metapelitic and metacarbonate sedimentary rocks belonging to the Wrangellia terrane (Ford and Brew, 1993);

(4) medium- to high-pressure, medium- to high-temperature pelitic schists together with minor amphibolitic schist and marble that are presently assigned to the Behm Canal structural zone (Brew and Ford, 1993, 1994) and have been described in detail by Himmelberg and others (1991, 1994a,b); the Late Cretaceous sills of the Mount Juneau pluton are within this unit (Ford and Brew, 1977a; Drinkwater and others, 1990);

(5) the well-foliated and locally lineated, intermediate-composition granitic rocks of the Great tonalite sill composite batholith (Brew and Ford, 1981; Brew, 1988; Gehrels and others, 1991; Ingram and Hutton, 1994), which is dated at 69 to 56 Ma and which was emplaced at or close to the contact between the Behm Canal structural zone to the west and the metamorphic rocks of the Nisling terrane to the east;

(6) layered biotite-hornblende gneiss, amphibole gneiss, quartz- and feldspar-rich schist, and multicomponent migmatite intruded by a series of broad hornblende-biotite granodiorite sills (Brew and Ford, 1985; Brew, 1988, 1994; Drinkwater and others, 1989, 1990), which are dated at 60 to 55 Ma and which are related to the Great tonalite sill;

(7) generally unfoliated, massive, and homogeneous sphene-biotite-hornblende granodiorite (50 Ma) of the Turner Lake batholith (Brew and Ford, 1985; Brew, 1988, 1994; Drinkwater and others, 1992a,b, 1994) with its sporadic screens of metamorphic rocks and local migmatite zones; and

(8) locally hornfelsed, intermediate-composition metavolcanic rocks of the Stikine terrane and pelitic and semipelitic schists of the Nisling terrane at and near the international boundary (Brew and Ford, 1985; Brew and others, 1994).

All these units fit into the metamorphic-plutonic zonation scheme given previously for the rocks of the Coast Mountains Complex as a whole (Brew and Ford, 1984). The western metamorphic belt consists of above units 1–4, the central metamorphic zone consists of units 5–6, the central granitic zone is unit 7, and the eastern metamorphic zone is unit 8.

Magmatic and metamorphic belt classifications for these rocks (Brew and Morrell, 1983; Brew, 1988, 1994; Brew and others, 1989, 1992) aggregate some of the units mentioned above into larger entities and partition some units into different parts. The point is that the rocks in the type area of the Coast Mountains Complex and in the other

parts of the complex can be described according to a variety of schemes that correspond to their varied attributes, but definition on the basis of other attributes would not affect the formal naming of the complex.

## REFERENCES CITED


Arth, J.G., Barker, F., and Stern, T.W., 1988, Coast batholith and Taku plutons near Ketchikan, Alaska: Petrography, geochronology, geochemistry, and isotopic character, *in* Sinha, A.K., ed., Frontiers in petrology: American Journal of Science, v. 288A, p. 461–489.

Barker, Fred, and Arth, J.G., 1984, Preliminary results, Central gneiss complex of the Coast Range batholith, southeastern Alaska: The roots of a high-K, calc-alkaline arc?: Physics of the Earth and Planetary Interiors, v. 35, p. 191–198.

Bates, R.L., and Jackson, J.A., eds., 1987, Glossary of geology (3d ed.): Alexandria, Va., American Geological Institute, 788 p.

Berg, H.C., Elliott, R.L., and Koch, R.D., 1988, Geologic map of the Ketchikan and Prince Rupert quadrangles, southeastern Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I–1807, 2 sheets, scale 1:250,000, 27-p. pamphlet.

Berg, H.C., Jones, D.L., and Richter, D.H., 1972, Gravina-Nutzotin belt—Tectonic significance of an upper Mesozoic sedimentary and volcanic sequence in southern and southeastern Alaska, *in* Geological Survey Research 1972: U.S. Geological Survey Professional Paper 800–D, p. D1–D24.

Brew, D.A., 1988, Latest Mesozoic and Cenozoic igneous rocks of southeastern Alaska—A synopsis: U.S. Geological Survey Open-File Report 88–405, 29 p., 24 figs.

———1994, Latest Mesozoic and Cenozoic magmatism in southeastern Alaska, *in* Plafker, G., and Berg, H.C., eds., The geology of Alaska, v. G–1 *of* The geology of North America: Boulder, Colo., Geological Society of America, p. 621–656.

Brew, D.A., and Ford, A.B., 1977, Preliminary geologic and metamorphic-isograd map of the Juneau B–1 quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF–846, scale 1:31,680.

——— 1978, Megalineament in southeastern Alaska marks southwest edge of Coast Range batholithic complex: Canadian Journal of Earth Sciences, v. 15, no. 11, p. 1763–1772.

———1981, The Coast plutonic complex sill, southeastern Alaska, *in* Albert, N.R.D., and Hudson, Travis, eds., The United States Geological Survey in Alaska: Accomplishments during 1979: U.S. Geological Survey Circular 823–B, p. B96–B99.

———1984, The northern Coast plutonic-metamorphic complex, southeastern Alaska and northwestern British Columbia, *in* Coonrad, W.L., and Elliott, R.L., eds., The United States Geological Survey in Alaska: Accomplishments during 1981: U.S. Geological Survey Circular 868, p. 120–124.

———1985, Preliminary reconnaissance geologic map of the Juneau, Taku River, Atlin and part of the Skagway 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 85–395, 23 p., 2 sheets, scale 1:250,000.

———1989, Note 57—Application for amendment of the North American Stratigraphic Code to provide for the exclusive informal use of the "form" terms such as batholith, intrusion, pluton, stock, plug, dike, sill, diapir, and body: American Association of Petroleum Geologists Bulletin, v. 73, p. 1452–1453.

———1990, Proposed revisions in stratigraphic code; a letter concerning Note 57—Application for amendment of the North American Stratigraphic Code to provide for the exclusive informal use of the "form" terms such as batholith, intrusion, pluton, stock, plug, dike, sill, diapir, and body: Geotimes, v. 35, no. 2, p. 6.

———1993, The Coast Mountains plutonic-metamorphic complex between Skagway, Alaska, and Fraser, British Columbia—Geologic sketch and road log: 1993 Geological Association of Canada NUNA Conference on the Northern Intermontane Superterrane, Whitehorse, Yukon Territory, August 22–28, 1993, Field Trip Guide, p. 1–21.

———1994, The Coast Mountains plutonic-metamorphic complex between Skagway, Alaska, and Fraser, British Columbia—Geologic sketch and road log: U.S. Geological Survey Open-File Report 94–268, 25 p.

Brew, D.A., Ford, A.B., and Garwin, S.L., 1985, Fossiliferous Middle and (or) Upper Triassic rocks within the Coast plutonic-metamorphic complex southeast of Skagway, *in* Bartsch-Winkler, Susan, ed., The United States Geological Survey in Alaska: Accomplishments during 1984: U.S. Geological Survey Circular 967, p. 86–89.

Brew, D.A., Ford, A.B., and Himmelberg, G.R., 1989, Evolution of the western part of the Coast plutonic-metamorphic complex, southeastern Alaska, U.S.A.—A summary, *in* Daly, J.S., Cliff, R.A., and Yardley, B.W.D., eds., Evolution of metamorphic belts: Geological Society of London Special Publication 43, p. 447–452.

———1994, Jurassic accretion of Nisling terrane along the western margin of Stikinia, Coast Mountains, northwestern British Columbia; Comment: Geology, v. 22, no. 1, p. 89–90.

Brew, D.A., Himmelberg, G.R., Loney, R.A., and Ford, A.B., 1992, Distribution and characteristics of metamorphic belts in the south-eastern Alaska part of the North American Cordillera: Journal of Metamorphic Geology, v. 10, p. 465–482.

Brew, D.A., Karl, S.M., Barnes, D.F., Jachens, R.C., Ford, A.B., and Horner, R.B., 1991, A northern Cordilleran ocean-continent transect: Sitka Sound, Alaska, to Atlin Lake, British Columbia: Canadian Journal of Earth Sciences, v. 28, no. 6, p. 840–853.

Brew, D.A., and Morrell, R.P., 1980, Preliminary map of intrusive rocks in southeastern Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF–1048, 1 sheet, with text, scale 1:1,000,000.

———1983, Intrusive rocks and plutonic belts in southeastern Alaska, U.S.A., *in* Roddick, J.A., ed., Circum-Pacific plutonic terranes: Geological Society of America Memoir 159, p. 171–193.

Brew, D.A., Ovenshine, A.T., Karl, S.M., and Hunt, S.J., 1984, Preliminary reconnaissance geologic map of the Petersburg and parts of the Port Alexander and Sumdum 1:250,000 quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 84–405, 43-p. pamphlet, 2 sheets, scale 1:250,000.

Buddington, A.F., 1927, Coast Range intrusives of southeastern Alaska: Journal of Geology, v. 35, p. 224–246.

Buddington, A.F., and Chapin, Theodore, 1929, Geology and mineral deposits of southeastern Alaska: U.S. Geological Survey Bulletin 800, 398 p.

Douglas, R.J.W., Gabrielse, H., Wheeler, J.O., Stott, D.F., and Belyea, H.R., 1970, Geology of western Canada, *in* Douglas, R.J.W., ed., Geology and economic minerals of Canada: Canada Geological Survey Economic Geology Report No. 1, p. 365–488.

Drinkwater, J.L., Brew, D.A., and Ford, A.B., 1989, Petrographic and chemical description of the variably deformed Speel River pluton, south of Juneau, southeastern Alaska, *in* Dover, J.H., and Galloway, J.P., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1988: U.S. Geological Survey Bulletin 1903, p. 104–112.

———1990, Petrographic and chemical data for the large Mesozoic and Cenozoic plutonic sills east of Juneau, southeastern Alaska: U.S. Geological Survey Bulletin 1918, 47 p.

———1994, Chemical characteristics of major plutonic belts of the Coast plutonic-metamorphic complex near Juneau, southeastern Alaska, *in* Till, A.B., and Moore, T.E., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1993: U.S. Geological Survey Bulletin 2107, p. 161–172.

Drinkwater, J.L., Ford, A.B., and Brew, D.A., 1992a, Magnetic susceptibilities and iron content of plutonic rocks across the Coast plutonic-metamorphic complex near Juneau, Alaska, *in* Bradley, D.W., and Dusel-Bacon, Cynthia, eds., Geologic studies in Alaska by the U.S. Geological Survey, 1991: U.S. Geological Survey Bulletin 2041, p. 125–139.

———1992b, Magnetic susceptibility measurements and sample locations of granitic rocks from along a transect of the Coast Mountains near Juneau, Alaska: U.S. Geological Survey Open-File Report 92–724, 22 p.

Forbes, R.B., and Engels, J.C., 1970, $K^{40}/Ar^{40}$ age relations of the Coast Range batholith and related rocks of the Juneau Ice Field area, Alaska: Geological Society of America Bulletin, v. 81, p. 579–584.

Ford, A.B., and Brew, D.A., 1973, Preliminary geologic and metamorphic-isograd map of the Juneau B–2 quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF–527, scale 1:31,680.

———1977a, Truncation of regional metamorphic zonation pattern of the Juneau, Alaska, area by the Coast Range batholith, *in* Blean, K.M., ed., The U.S. Geological Survey in Alaska: Accomplishments during 1976: U.S. Geological Survey Circular 751–B, p. 85–87.

———1977b, Preliminary geologic and metamorphic-isograd map of northern parts of the Juneau A–1 and A–2 quadrangles, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF–847, scales 1:125,000 and 1:31,680.

———1988, Major-element geochemistry of metabasalts of the Juneau-Haines region, southeastern Alaska, *in* Galloway, J.P., and Hamilton, T.D., eds., Geologic studies in Alaska by the U.S. Geological Survey during 1987: U.S. Geological Survey Circular 1016, p. 150–155.

———1993, Geochemical character of upper Paleozoic and Triassic greenstone and related metavolcanic rocks of the Wrangellia terrane in northern southeastern Alaska, *in* Dusel-Bacon, Cynthia, and Till, A.B., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1992: U.S. Geological Survey Bulletin 2068, p. 197–217.

Gehrels, G.E., McClelland, W.C., Samson, S.D., Patchett, P.J., and Brew, D.A., 1991, U-Pb geochronology of Late Cretaceous and early Tertiary plutons in the northern Coast Mountains batholith: Canadian Journal of Earth Sciences, v. 28, no. 6, p. 899–911.

Gehrels, G.E., McClelland, W.C., Samson, S.D., Patchett, P.J., and Jackson, J.L., 1990, Ancient continental margin assemblage in the northern Coast Mountains, southeast Alaska and northwest Canada: Geology, v. 18, p. 208–211.

Himmelberg, G.R., Brew, D.A., and Ford, A.B., 1991, Development of inverted metamorphic isograds in the western metamorphic belt, Juneau, Alaska: Journal of Metamorphic Geology, v. 9, p. 165–180.

———1994a, Evaluation and application of garnet amphibolite thermobarometry, western metamorphic belt near Juneau, Alaska, *in* Till, A.B., and Moore, T.E., eds., Geologic studies in Alaska by the U.S. Geological Survey, 1993: U.S. Geological Survey Bulletin 2107, p. 185–198.

———1994b, Petrologic characterization of pelitic schists in the western metamorphic belt, Coast plutonic-metamorphic complex, near Juneau, southeastern Alaska: U.S. Geological Survey Bulletin 2074, 18 p.

———1995, Low-grade, $M_1$ metamorphism of the Douglas Island Volcanics, western metamorphic belt near Juneau, Alaska, *in* Schiffman, Peter, and Day, H.W., eds., Low-grade metamorphism of mafic rocks: Geological Society of America Special Paper 296, p. 51–66.

Holland, S.S., 1964, Landforms of British Columbia—A physiographic outline: British Columbia Department of Mines and Petroleum Resources Bulletin 48, 138 p.

Ingram, G.M., and Hutton, D.H.W., 1994, The Great Tonalite Sill: Emplacement into a contractional shear zone and implications for Late Cretaceous to early Eocene tectonics in southeastern Alaska and British Columbia: Geological Society of America Bulletin, v. 106, p. 715–728.

Karl, S.M., and Brew, D.A., 1984, Migmatites of the Coast plutonic-metamorphic complex, southeastern Alaska, *in* Reed, K.M., and Bartsch-Winkler, Susan, eds., The United States Geological Survey in Alaska: Accomplishments during 1982: U.S. Geological Survey Circular 939, p. 108–111.

Lathram, E.H., Pomeroy, J.S., Berg, H.C., and Loney, R.A., 1965, Reconnaissance geology of Admiralty Island, Alaska: U.S. Geological Survey Bulletin 1181–R, p. R1–R48, 2 maps, scale 1:250,000.

Monger, J.W.H., Price, R.A., and Tempelman-Kluit, D.J., 1982, Tectonic accretion and the origin of the two major metamorphic and plutonic welts in the Canadian Cordillera: Geology, v. 10, p. 70–75.

North American Commission on Stratigraphic Nomenclature, 1983, North American Stratigraphic Code: American Association of Petroleum Geologists Bulletin, v. 67, no. 5, p. 841–875.

Orth, D.J., 1967, Dictionary of Alaska place names: U.S. Geological Survey Professional Paper 567, 1,084 p.

Roddick, J.A., and Hutchison, W.W., 1974, Setting of the Coast plutonic complex, British Columbia: Pacific Geology, v. 8, p. 91–108.

Souther, J.G., 1971, Geology and mineral deposits of the Tulsequah map area, British Columbia: Canada Geological Survey Memoir 362, 84 p.

Wahrhaftig, Clyde, 1965, Physiographic divisions of Alaska: U.S. Geological Survey Professional Paper 482, 52 p.