Chapter 19

Latest Mesozoic and Cenozoic magmatism in southeastern Alaska

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INTRODUCTION

The most important latest Mesozoic and Cenozoic, post-accretionary geologic features of southeastern Alaska are those related to the magmatic activity that affected a large part of the region and to the resultant metamorphism and deformation. The metamorphic history is discussed elsewhere in this volume (Dusel-Bacon, this volume), and the magmatic activity is a continuation of the late Mesozoic activity discussed by Miller (this volume). Postaccretionary geologic history starts with the accumulation of the Gravina belt overlap assemblage of rocks in Late Jurassic and Early Cretaceous time (Berg and others, 1972). The locally voluminous volcanic rocks within that assemblage are probably the extrusive equivalents of island-arc intrusive rocks, which are preserved west of the Gravina belt over a large area in northern southeastern Alaska (Brew and Morrell, 1983). Neither the volcanics nor the granitoids are discussed in this chapter.

Previous syntheses concerned with the magmatic rocks of southeastern Alaska comprise a summary of post-Carboniferous volcanic activity (Brew, 1968), summaries of the distribution and general characteristics of the plutonic rocks (Brew and Morrell, 1980, 1983), a summary of the geochronologic data available (Wilson and Shew, 1982), and two reports concerned with the tectonic significance of major- and trace-element chemical data (Barker and Arth, 1984; Barker and others, 1986). Karl and Brew (1984) discussed migmatic rocks associated with some of the intrusive rocks; that topic is not considered in this report.

In this chapter, the latest Mesozoic and Cenozoic magmatic rocks are grouped chronometrically (Table 1); the same time divisions are used elsewhere in this volume for the Cenozoic magmatic history of the rest of Alaska (Moll-Stalcup, this volume). The divisions are approximate, and several of the belts described in the region include rocks whose radiometric ages fall somewhat outside of the defined limits. Within each chronometric group, extrusive and intrusive rocks are identified compositionally and are separated into geographic belts. The general approach is similar to that of Brew and Morrell (1983). Table 2 provides summary information on modal and chemical compositions, chronometric data, and emplacement/eruptive environment for each of the chronometric groups. The chemical classifications of the rocks are those of Shand (1951) and Irvine and Baragar (1971). Figure 1 shows the general geographic distribution of the rocks of different ages and is an index map for the descriptions in the table.

Magmatic activity in southeastern Alaska ranges from early Paleozoic to Holocene in age but was most frequent in the late Mesozoic and Cenozoic. Currently available geochronologic data for southeastern Alaska are summarized in Figure 2, which shows the frequency distribution for 40Ar age determinations of all types of rocks from southeastern Alaska southeast of the Yakutat 1:250,000 scale quadrangle. The relative recency of magmatic activity in the region is obvious, as are the dominance of mid-Tertiary events and the absence of any real break between Mesozoic and Cenozoic events.

DESCRIPTION OF THE TABLES

Table 1 links the major magmatic belts and areas of summary discussions in the text, shown on Figure 3, with the descriptions of the component belts and areas given in Table 2. The information presented in Tables 1 and 2 is derived from a report in preparation; that report contains more discussion of tectonic settings, emplacement situations, and extrusive activity than can be included here. Table 2 summarizes the data that support the conclusions of this chapter.

Table 2 is divided into columns for: (1) Figure 1 reference, which is the letter designation on those maps for the specific area; (2) area or belt name; (3) major and minor lithic types, with the latter shown in parentheses (granitic rock names are from Streckeisen, 1973); (4) chemical classification and chemical compositional types present, based on calculations using the PTECAL 4 program (Bingler and others, 1976) as revised by R. D. Koch (written communication, 1985); (5) SiO2 range; (6) SiO2 gap(s); (7) reference to map and diagram figures in this report; most figures include a Streckeisen (1973) QAP (quartz-alkali feldspar plagioclase feldspar) classification diagram for granitic rocks, a silica-variation diagram, an AFM (alkaline element oxide–iron oxide–magnesium oxide) diagram, and a small map showing the area containing the rocks described; (8) age data; (9) discussion or remarks, focussed mainly on the environment of pluton emplacement or volcanic extrusion; and (10) references to the sources of the data.


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**TABLE 1. MAJOR LATEST MESOZOIC AND CENOZOIC MAGMATIC BELTS AND AREAS OF SOUTHEASTERN ALASKA**

<table>
<thead>
<tr>
<th>Major Area or Belt Name (Age Division)</th>
<th>Components of the Major Area or Belt Name (Figure 1 and Table 2 Reference)</th>
<th>Individual Area or Belt Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great tonalite sill belt area (75–55 Ma)</td>
<td>GG Juneau-Skagway area, HH Haines-Skagway area, II Juneau-Taku River area, JJ Sundum area, KK Petersburg area, LL Bradfield Canal area, MM Ketchikan–Prince Rupert area.</td>
<td></td>
</tr>
<tr>
<td>Coast Mountains belt (55–45 Ma)</td>
<td>AA Haines-Skagway area, BB Juneau-Taku River area, CC Sundum (Tracy Arm) area, DD Petersburg area, EE Bradfield Canal area, FF Ketchikan–Prince Rupert area.</td>
<td></td>
</tr>
<tr>
<td>Fairweather-Baranof belt (45–35 Ma)</td>
<td>Y Fairweather Range, Z Yakobi, Chichagof, and Baranof area.</td>
<td></td>
</tr>
<tr>
<td>Glacier Bay region (45–35 Ma)</td>
<td>X Glacier Bay region.</td>
<td></td>
</tr>
<tr>
<td>Grouchoch Basin–Cone Mountain (35–5 Ma)</td>
<td>O Groundhog Basin area, T Cone Mountain area.</td>
<td></td>
</tr>
<tr>
<td>Southern southeastern Alaska dike swarm (35–5 Ma)</td>
<td>W Southern southeastern Alaska dike swarm.</td>
<td></td>
</tr>
<tr>
<td>Kruzof–Kupreanof area (5–0 Ma)</td>
<td>A Edgecumbe field, B Southern Kupreanof field.</td>
<td></td>
</tr>
<tr>
<td>Behm Canal–Rudyerd Bay area (5–0 Ma)</td>
<td>C Blue River–Unuk River field, D Behm Canal–Rudyerd Bay field.</td>
<td></td>
</tr>
</tbody>
</table>

**EVOLUTION OF MAGMATIC BELTS AND AREAS**

The tectonic settings and compositional variations recorded in the several Cenozoic magmatic belts of southeastern Alaska indicate a varied and complicated evolutionary history. The older part of the record, from latest Cretaceous through about early Oligocene time, reflects the two main collisional events that dominate the Cenozoic history of the region. The younger part of the record, from the late Oligocene on, is the result of less well-understood events, ones that are probably related first to oblique subduction and then to extensional regimes associated with youngest Cenozoic strike-slip faulting.

The areas summarized in Tables 1 and 2 are grouped into nine major belts on Figure 3: one of latest Cretaceous and Paleocene age (75 to 55 Ma), one of early and middle Eocene age (55 to 45 Ma), two of middle and late Eocene and early Oligocene age (45 to 35 Ma), three of late Oligocene and Miocene age (35 to 5 Ma), and two of Pliocene and Quaternary age (5 to 0 Ma). Each of these belts is interpreted to record a specific magmagenic event (or series of events) and most have clear-cut chemical and/or modal compositional features that support the definition of the belts.

Figures 4 through 23 are keyed to Table 2 and are therefore not referred to specifically in the following summary discussion.

**Great tonalite sill belt**

The oldest belt discussed here, the latest Cretaceous and Paleocene “great tonalite sill” belt (Skagway/Ketchikan–Prince Rupert [75 to 55 Ma] on Fig. 3 and Tables 1 and 2), records only the youngest of a series of events that began in Early Cretaceous time in the “southeastern Alaska coincident zone” (Brew and Ford, 1983). The rocks of the tonalite sill belt are consistently calc-alkaline and dominantly metaluminous, locally have a prominent silica gap at 63 to 68 percent, and fall in the tonalite–granodiorite–quartz monzonite–quartz diorite–diortite of Streckeisen (1973). These plutons have emplacement ages that range from 67 to 55 Ma. The sill rocks with Paleocene emplacement ages of around 60 Ma are included with the older tonalite sill family because of their closely similar ages and habits. They are mostly granodiorite and have higher silica contents than the slightly older rocks.

The plutons of the great tonalite sill family are foliated and lineated tonalites that form a narrow belt. They have been localized along a profound, straight, structural discontinuity within a convergent setting in which the northeast side was moving upward over the southwest side (D.H.W. Hutton, personal communication, 1985, 1986). This discontinuity can be interpreted as an inherent rift margin (Brew and Ford, 1983) or as the boundary between two exotic terranes (Monger and others, 1982, 1983). The linear zone of compression persisted at least from 70 to 55 Ma, the tonalite period during which intrusions were emplaced. Metamorphism and major deformation occurred shortly before the emplacement of the intrusions.

The cause of the compression in this zone, whether it was
<table>
<thead>
<tr>
<th>Figure 1 and Table 1 references</th>
<th>Area or Belt Name</th>
<th>Major (and Minor) Lithic Types</th>
<th>Chemical Classification</th>
<th>SiO₂ Range (%)</th>
<th>SiO₂ Gap (%)</th>
<th>Map and Diagrams on Figure</th>
<th>Age Data</th>
<th>Discussion</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Edgecumbe field</td>
<td>Basalt, basaltic, andesite, andesite, dacite, (rhyolite)</td>
<td>Tholeiitic, calc-alkaline</td>
<td>47-72 (nephelae); 52-74 (tephra)</td>
<td>62-69</td>
<td>4, 5 (location)</td>
<td>Late Pleistocene and younger on K-Ar data (M.A. Langphere, written communication, 1985) and microfossils (W.V. Sitter, written comm., 1985)</td>
<td>Basalt tholeiitic basalt shield surmounted by calc-alkaline andesite cones and dacite plugs, basaltic to rhyolitic tephras all younger than 10,000 B.P.</td>
<td>Brew and others, 1969; Myers and others, 1984; Kosco, 1981; Riehl and Brew, 1984, unpublished data</td>
</tr>
<tr>
<td>B</td>
<td>Southern Kupre- anof field</td>
<td>Olivine-bearing basalt</td>
<td>Mostly tholeiitic; aver. K content; some alkalic; sodic</td>
<td>45-63</td>
<td>5</td>
<td>Younger than 300 ka on K-Ar data</td>
<td>Pahoehoe and aa flows, some plugs</td>
<td>Brew and others, 1984, 1985; Douglass and others, 1989</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Blue River-Unuk River field</td>
<td>Alkaline olivine basalt</td>
<td>Mostly alkalic, sodic; some calc-alkaline; K-rich</td>
<td>46-48</td>
<td>5</td>
<td>As young as 360 ± 60 B.P. on radon-carbon</td>
<td>Valley-filling flows, small cinder cones</td>
<td>Elliott and others, 1981; Southard and others, 1984</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Tlovak Strait- Suemez field</td>
<td>Olivine basalt</td>
<td>Alkaline; sodic</td>
<td>47</td>
<td>No data</td>
<td>Pahoehoe surfaces, valley-filling flows</td>
<td></td>
<td>Eberlein and Churkin, 1970; Eberlein and others, 1983; G.D. Eberlein, written communication, 1986</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Behm Canal- Rudyard Bay field</td>
<td>Olivine basalt, basaltic breccia and tuff, andesite (trachyan-desite)</td>
<td>Alkaline; mostly potassic</td>
<td>43-61</td>
<td>46-59</td>
<td>5</td>
<td>Possibly two periods: 5 Ma and 1 Ma to 600 ka (Smith and Diggles, 1981)</td>
<td>Columnar flows, cinder cones</td>
<td>Wanek and Callahan, 1971; Berg and others, 1988; Smith and others, 1977; Oderberk, 1982; Doyle, 1983; Souther and others, 1984</td>
</tr>
<tr>
<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO$_2$ Range (%)</td>
<td>SiO$_2$ Gap (s) (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
<td>Discussion</td>
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<tr>
<td>Late Oligocene and Miocene Rocks (35–5 Ma)</td>
<td>F</td>
<td>Tokpo volcanic-plutonic belt</td>
<td>In Canada: granophyre, granite, quartz monzonite, granodiorite, quartz diorite gabbro. In U.S.: homblesde-biotite granite</td>
<td>Calc-alkaline except for gabros, which are on calc-alkaline-tholeitic boundary</td>
<td>49–77</td>
<td>51–59</td>
<td>N.A.</td>
<td>26–24 Ma on K-Ar, Rb-Sr, and fission track</td>
<td>Main expression is epizonal, composite Tokpo River pluton in Canada; extension into U.S.A. consists of plugs, dikes, and small plutons</td>
</tr>
<tr>
<td>G</td>
<td>Haines area</td>
<td>Biotite quartz monzonite, locally psammomictic</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>No data</td>
<td>Age inferred from lithic similarity to Kuluketlin belt plutons</td>
<td>Redman and others, 1984</td>
</tr>
<tr>
<td>H</td>
<td>Fairweather Range</td>
<td>Garnet-muscovite-biotite granite and granodiorite</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>5.9 Ma on biotite and 16.6 Ma on muscovite (M. A. Lamphere, written communication, 1978)</td>
<td>May belong with nearby early Oligocene and late Eocene bodies</td>
<td>Brew and others, 1978; D. A. Brew, unpublished data</td>
</tr>
<tr>
<td>I</td>
<td>Lituya Bay area</td>
<td>Tuffs, flows of andesite and basaltic andesite</td>
<td>Calc-alkaline, K-poor, 54 per Irvine and Baragar (1971)</td>
<td>N.A.</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Post–early Oligocene(?) to pre-middle Miocene (Miller, 1961)</td>
<td>Eocene volcanics of unit of Miller (1961); nonmarine</td>
<td>Plafker, 1971; G. Plafker, written communication, 1986</td>
</tr>
<tr>
<td>J</td>
<td>William Henry Bay area</td>
<td>Biotite quartz monzonite, diorite</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>No data</td>
<td>Age inferred by Eakins (1975) on lithic ground(s)?</td>
<td>Eakins, 1975; Brew and Ford, 1985; Brew and Ford, 1986</td>
</tr>
<tr>
<td>K</td>
<td>Icy Strait volcanic-plutonic belt</td>
<td>Homblesde granite, homblesde quartz monzonite, breccia, flows, and tuft of diorite, andesite, and basal</td>
<td>Volcanic rocks, mostly tholeitic, aker. K content; also calc-alkaline, aker. K content; no data on granitoids</td>
<td>47–72</td>
<td>61–68</td>
<td>6, 7</td>
<td>Two episodes; 25 Ma and 16 Ma on whole-rock K-Ar (G. Plafker, written communication, 1986)</td>
<td>Linkage between plutons and volcanics is tenuous; REE diagram shows differentiated trend trend with higher SiO$_2$ rocks having negative Europium anomalies</td>
<td>Brew and Ford, 1986; D. A. Brew, unpublished data; G. Plafker, written communication, 1986; Fukuhara, 1986</td>
</tr>
<tr>
<td>L</td>
<td>Gut Bay area</td>
<td>Homblesde-biotite granodiorite, tonalite, tonalite, gabbro</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>24.3 Ma on biotite; 24.9 Ma and 31.5 Ma on coexisting biotite and homblesde, respectively</td>
<td>Heterogeneous intrusion</td>
<td>Loney and others, 1975</td>
</tr>
<tr>
<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap (%)</td>
<td>Map and Diagrams on Figure</td>
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<tr>
<td>M</td>
<td>Admiralty field</td>
<td>Andesite and basalt flows, (rhyolite tuff and breccia)</td>
<td>Mostly tholeiitic per MacDonald and Katsura (1984), but calc-alkaline (aver. K content) per Irvine and Baragar (1971)</td>
<td>47-58</td>
<td>N.A.</td>
<td>6, 7</td>
<td>1,500-2,500 m thick alteration common</td>
<td>Oligocene plant fossils (J. A. Wolfe, written communication, 1985); 27 Ma whole-rock K-Ar (G. Plafker, written communication, 1986)</td>
<td>Loney, 1964; Latham and others, 1985; G. Plafker, written communication, 1986</td>
</tr>
<tr>
<td>N</td>
<td>Kulu-Etolin volcanic-plutonic belt</td>
<td>Basalt and andesite flows; rhyolite flows and tufts, vent and other breccias; alkali granite, granite, quartz syenite (gabbro)</td>
<td>Volcanics mostly tholeiitic per MacDonald and Katsura (1964) and Miyashiro (1974), but calc-alkaline, (1974) aver. and low K-content per Irvine and Baragar (1971). Granitics are mostly peraluminous and metaluminous, calcalkaline, K-poor or K-aver., and only a few are peralcaline or alkalic</td>
<td>46-76 (volcanics)</td>
<td>61-65 (granitoids)</td>
<td>8, 9, 10</td>
<td>Volcanics 22-20 Ma on whole-rock K-Ar; granitoids 19-24 Ma (Douglass and others, 1987)</td>
<td>Heterogeneous volcanic and plutonic complex; gabbro and microgabbro low in section; silicic volcaniclastic rocks associated with rhyolite; large, well-zoned granitoid body at east end of belt; basalts and andesites have no negative Europium anomaly, rhyolites a strong one, granitoids are in between</td>
<td>Brew and others, 1979, 1984; Hunt, 1984; Douglass and others, 1989</td>
</tr>
<tr>
<td>O</td>
<td>Groundhog Basin area</td>
<td>Phylolite, biotite granite</td>
<td>Peraluminous per Shand (1951); tholeiitic per MacDonald and Katsura (1964), but calc-alkaline, K-poor per Irvine and Baragar (1971)</td>
<td>74-76</td>
<td>10</td>
<td>10</td>
<td>Stil 15 Ma on whole-rock K-Ar; plug 16 Ma on biotite K-Ar</td>
<td>Prominent rhyolite sill swarm apparently centered on granitic or felsic volcanic plugs</td>
<td>Brew and others, 1984; Douglass and others, 1989; R. P. Morrell, written communication, 1986</td>
</tr>
<tr>
<td>P</td>
<td>Southern Etolin field</td>
<td>Basalt flows, andesite breccias</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>No data</td>
<td>May be outlier of Kulu-Etolin volcanics</td>
<td>Berg and others, 1976; Eberlein and others, 1983</td>
</tr>
<tr>
<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap(s) (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
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<tr>
<td>Late Oligocene and Miocene Rocks (35–5 Ma)</td>
<td>East-central Prince of Wales field</td>
<td>Basalt and rhyolite breccia and tuff</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>No data</td>
<td>Very poorly known small isolated occurrences</td>
<td>Eberlein and others, 1983</td>
</tr>
<tr>
<td></td>
<td>Suemez field</td>
<td>Olivine basalt flows, basalt breccia, lapilli tuff, rhyolite and dacite flows</td>
<td>Peralkaline per Irvine and Baragar (1971); tholeiitic per MacDonald and Katsura (1964)</td>
<td>72</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Associated with Tertiary (?) coal seams</td>
<td>Poorly known field, may be closely related to Tievak field (D)</td>
<td>Eberlein and others, 1983; G. D. Eberlein, written communication, 1986</td>
</tr>
<tr>
<td></td>
<td>Burroughs Bay area</td>
<td>Biotite granite and biotite quartz monzonite</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>23 Ma K-Ar on biotite + chlorite (Hudson and others, 1979)</td>
<td>Quartz porphyry stock and dike swarm; explored for molybdenum</td>
<td>Hudson and others, 1979; Berg and others, 1988; R. L. Elliott and R. D. Koch, written communication, 1986</td>
</tr>
<tr>
<td></td>
<td>Cone Mountain area</td>
<td>Alkali-feldspar granite (rhyolite)</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>N.A.</td>
<td>Miocene (?) reported by Koch and Elliott (1981)</td>
<td>May be similar to Groundhog Basin area (0)</td>
<td>Koch and Elliott, 1981; R. L. Elliott and R. D. Koch, written communication, 1986</td>
</tr>
<tr>
<td></td>
<td>Ketchikan area</td>
<td>Olivine-bearing pyroxene leucogabbro (gabbro, quartz diorite, and gneiss)</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>N.A.</td>
<td>24 Ma K-Ar on biotite; 25 Ma K-Ar on hornblende (Smith and Diggles, 1981)</td>
<td>May be distant member of Quartz Hill–Portland Peninsula group of plutons</td>
<td>Koch and Elliott, 1984; Berg and others, 1988</td>
</tr>
<tr>
<td></td>
<td>Quartz Hill–Portland Peninsula area</td>
<td>Olivine-hypersthene-augite gabbro, biotite granite, granite porphyry, biotite quartz monzonite</td>
<td>Granitoids: peraluminous, calc alcaline; gabbro: metaluminous, tholeiitic</td>
<td>47–78</td>
<td>48–73</td>
<td>11</td>
<td>Two episodes based on K-Ar: one at 30 Ma and one between 27 and 24 Ma</td>
<td>Four plutons in crude E-trending belt—one contains major molybdenite deposit (Quartz Hill); strongly fractionated REE patterns and large Europium anomalies for granitoids, Sin initial ratios 0.747 to 0.7051 (Arth and others, 1989)</td>
<td>Elliott and others, 1976; Hudson and others, 1979</td>
</tr>
</tbody>
</table>
### Table 2. Description of Latest Mesozoic and Cenozoic Magmatic Rocks of Southeastern Alaska (continued)

<table>
<thead>
<tr>
<th>Figure 1 and Table 1 references</th>
<th>Area or Belt Name</th>
<th>Major (and Minor Lithic Types)</th>
<th>Chemical Classification</th>
<th>SiO₂ Range (%)</th>
<th>SiO₂ Gap (%)</th>
<th>Map and Diagrams on Figure</th>
<th>Age Data</th>
<th>Discussion</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Glacier Bay region</td>
<td>Biotite granite; alkali granite</td>
<td>Per-and met-aluminous, dominantly calc-alkalic</td>
<td>58-76</td>
<td>71-75</td>
<td>12</td>
<td>42 to 31 Ma on K-Ar (12 determinations, M. A. Lanphere, oral communication, 1967, 1968, 1980)</td>
<td>Plutonic rocks slightly younger than in following two areas (Y and Z); body of Muir Inlet is associated with a Cu-Mo deposit</td>
<td>MacKevett and others, 1971, 1974; Brew and others, 1978; Brew, unpublished data; Himmelberg and Loney, 1981; Plafker and MacKevett, 1970</td>
</tr>
<tr>
<td>Y</td>
<td>Fairweather Range</td>
<td>Biotite granodiorite, biotite-hornblende quartz diorite and diorite; olivine gabbro, olivine norrito, (olivine gabbronite, anorthosite, wehrlite, dunite)</td>
<td>No data for granitoids but similar rocks not far NW are peraluminous, calc-alkalic; gabroids are met-aluminous, dominantly theolitic</td>
<td>Granitoids: 72-73</td>
<td>N.A.</td>
<td>N.A.</td>
<td>No data on granitoids; indirect dating of gabroids in that they are cut by felsic intrusives of above group (X)</td>
<td>This area and following area (Z) both contain a gabroic and an intermediate to felsic suite; this area has dominant layered gabbros; area Z has dominant intermediate to felsic intrusives; LaPerouse layered gabbro is host of major magmatic Ni-Cu deposit</td>
<td>As above, plus Hudson and others, 1977; Loney and Himmelberg, 1983</td>
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<td>Figure 1 and Table 1 References</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>$\text{SiO}_2$ Range (%)</td>
<td>$\text{SiO}_2$ Gap(s) (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
<td>Discussion</td>
<td>References</td>
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<td></td>
<td>Late and Middle Eocene and Early Oligocene Rocks (45–35 Ma)</td>
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<td>Z</td>
<td>Yakobi, Chichagof, and Baranof area</td>
<td></td>
<td>Garnet-muscovite-bearing biotite-hornblende granodiorite and granite, biotite granodiorite, muscovite-hornblende-biotite tonalite, hornblende quartz diorite, hornblende-pyroxene gabbronorite, hornblende pyroxenite, (quartz-bearing norite, leucogabbro)</td>
<td>Granitoids dominantly metaluminous, calc-alkaline; K content; gabbroids metaluminous, calc-alkaline and tholeiitic, both aver. K content</td>
<td>Granitoids: 51–73</td>
<td>Granitoids: 58–65</td>
<td></td>
<td>43–40 Ma K-Ar on hornblende and biotite from tonalite on Yakobi (M.A. Lanphere, written communication, 1982; F. H. Wilson, written commun., 1985); 49 Ma K-Ar on biotite from granodiorite on Kruzeof (Loney and others, 1967); 47–42 Ma K-Ar on biotite and hornblende from granodiorite and tonalite on Baranof (Loney and others, 1967)</td>
<td>See above; gabbronitite on Yakobi is host of Cu deposit; REE diagram shows relatively undifferentiated trends. Kruzeof pluton has $87^{Sr}/86^{Sr}$ values of about 0.70535; (Myers and others, 1984)</td>
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<td></td>
<td>Early and Middle Eocene Rocks (55–45 Ma)</td>
<td></td>
<td>K-feldspar-porphyritic hornblende quartz monzodiorite, K-feldspar-porphyritic hornblende-biotite quartz monzodiorite and granite, hornblende-biotite tonalite and granodiorite, biotite granite</td>
<td>Tonalite to W dominantly peraluminous (8.3); rest metaluminous, calc-alkaline, aver. and high K content; granodiorite and granite to E equally peraluminous and metaluminous, calc-</td>
<td>53–77</td>
<td>N.A.</td>
<td>14A, 15</td>
<td>Tonalite and granodiorite 54 Ma on Pb/U on zircon, 52 Ma on K-Ar on biotite; granite 52–51 Ma on Pb/U on zircon to E, 48 Ma to W (Barker and others, 1986)</td>
<td>Assignment of rocks north of Haines based on lithic similarity to rocks to E and S; if assignment is correct, then this is the only known occurrence of an early Eocene body W of the &quot;tonalite sill&quot; family A. B. Ford, unpublished data</td>
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<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
<td>Discussion</td>
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<td>CC</td>
<td>Surdam (Tracy Arm) area</td>
<td>Sphene-hornblende biotite granodiorite and granite, sphene-biotite-hornblend- e granodiorite, hornblende granodiorite; locally porphyritic</td>
<td>Dominantly (2:1) metaluminous, rest peraluminous, calc-alkaline-aver. K content</td>
<td>59–75 N.A.</td>
<td>17</td>
<td>54–49 Ma K-Ar on numerous biotite and hornblende samples (J. G. Smith, written communication, 1976, 1986)</td>
<td>Southeastward continuation of very large composite pluton of Juneau-Taku River area</td>
<td>Brew and Grybeck, 1984; D. A. Brew and A. B. Ford, unpublished data</td>
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<td>DD</td>
<td>Petersburg area</td>
<td>Locally K-spar-porphyritic sphene-bearing biotite-hornblende granodiorite, tonalite, and granite</td>
<td>Dominantly peraluminous, calc-alkaline-aver. K content</td>
<td>64–75 N.A.</td>
<td>17, 18</td>
<td>52–49 Ma K-Ar on biotite and hornblende (Douglas and others, 1987)</td>
<td>Large discrete pluton with complicated border phases</td>
<td>Brew and others, 1984; Webster, 1984; Douglas and others, 1989</td>
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<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
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<td>Early and Middle Eocene Rocks (55–45 Ma)</td>
<td>Ketchikan–Prince Rupert area</td>
<td>Locally K-spar-porphryritic spheroidite-bearing biotite-hornblende granodiorite, granite, and tonalite</td>
<td>Peraluminous dominant over metaluminous 2:1; calc-alkalic–aver. K-content</td>
<td>58–72</td>
<td>60–65</td>
<td>19</td>
<td>55–45 Ma on K-Ar from biotite and hornblende (Smith and Diggles, 1961)</td>
<td>Major bodies are continuations of those in Bradfield Canal area; probably several close-spaced intrusive episodes represented; strongly fractionated REE patterns with small negative EU anomalies; Sr initial ratios 0.7046–0.7061; area connects to SE in British Columbia with Ponder Pluton (Hutchison, 1982) and Mo-bearing Alice Arm intrusions (Woodcock and Carter, 1978; Christopher and Carter, 1976)</td>
<td>Berg and others, 1988; Smith, 1977; Smith and others, 1977; Woodcock and Carter, 1978; Hutchison, 1982; Arth and others, 1986</td>
</tr>
<tr>
<td>Paleocene Rocks (65–55 Ma)</td>
<td>Juneau–Skagway area</td>
<td>Foliated hornblende granodiorite and tonalite; biotite-hornblende granodiorite</td>
<td>Equal peraluminous and metaluminous; calc-alkalic–aver. K-content, some K-rich</td>
<td>57–76</td>
<td>N.A.</td>
<td>20</td>
<td>60 Ma on zircon (Gehrels and others, 1984) is supported by unpublished zircon age (G.R. Tilson, written communication, 1986) and K-Ar ages (F. H. Wilson, written communication, 1985, 1986)</td>
<td>Structurally more complicated than above (45–65 Ma) suite; modally and chemically in between the above suite and that below (65–75 Ma); plutons are generally stubby sills. Part of “great tonalite sill” family</td>
<td>Brew and Ford, 1986</td>
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<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap (%)</td>
<td>Map and Diagrams on Figure</td>
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<td>IK</td>
<td>Petersburg area</td>
<td>Generally well foliated, locally well lineated biotite-hornblende and hornblende-biotite tonalite, quartz diorite (granodiorite).</td>
<td>Meta- to peraluminous ratio is 10.5:1; calcalkaline–dominantly K-rich, some ever. K-content.</td>
<td>54–67.</td>
<td>63–68?</td>
<td>22B, 23</td>
<td>No reliable ages available. “Great tonalite silt” family consists of four large homogeneous bodies; migmatitic unit between two of them. Brew and others, 1984; Douglas and others, 1989</td>
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<tr>
<td>Figure 1 and Table 1 references</td>
<td>Area or Belt Name</td>
<td>Major (and Minor) Lithic Types</td>
<td>Chemical Classification</td>
<td>SiO₂ Range (%)</td>
<td>SiO₂ Gap(s) (%)</td>
<td>Map and Diagrams on Figure</td>
<td>Age Data</td>
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<td>Latest Cretaceous Rocks (75–65 Ma)</td>
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<td>LL</td>
<td>Bradfield Canal area</td>
<td>Granodiorite and quartz diorite</td>
<td>No data</td>
<td>No data</td>
<td>No data</td>
<td>N.A.</td>
<td>No data</td>
<td>&quot;Great tonalite sill&quot; family consists of continuations from the Petersburg area (LL) that dike out or otherwise die out to the SE</td>
<td>Koch and Elliott, 1981; R. L. Elliott and R. D. Koch, oral communication, 1986</td>
</tr>
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<td>MM</td>
<td>Ketchikan–Prince Rupert area</td>
<td>Foliated biotite-hornblende quartz diorite and tonalite, granodiorite</td>
<td>Met- to por- aluminous ratio 5:1; calc-alkalic–aver. K-content and K-rich in equal amounts</td>
<td>56–62</td>
<td>N.A.</td>
<td>23</td>
<td>58 to 55 Ma on zircon (Berg and others, 1988)</td>
<td>Extension of &quot;great tonalite sill&quot; family into British Columbia is Quuq-exploration to International Boundary that single homogenized body resembles the family further N, but intervening area (to Bradfield Canal [LL]) is a poorly understood zone 25 km wide with several narrow sills; Arth and others (1988) report mildly fractionated REE patterns with small negative Eu anomalies and Sr initial ratios of 0.7063–0.7064</td>
<td>Berg and others, 1988; Smith and others, 1977; Hutchison, 1982; Arth and others, 1986</td>
</tr>
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</table>
Figure 1. Cenozoic plutonic and volcanic rock localities in southeastern Alaska. Letters refer to areas described in Tables 1 and/or 2. Lined pattern indicates approximate extent of areas; boundaries between contiguous areas of the same age are omitted. Lines labelled “W” are the northwest and southeast boundaries of the southern southeastern Alaska dike swarm.

Figure 2. Histogram showing distribution of radiometric ages for southeastern Alaska.
Figure 3. Latest Mesozoic and Cenozoic magmatic belts, fields, and areas in southeastern Alaska. Ages given in parentheses are those from the organization of the text and table and do not in every case reflect the full range of ages of the rocks in the belts. One hundred and twenty kilometers of right-lateral separation on the Lynn Canal-Chatham Strait fault has been removed. Different types of lines are used only to clarify distributions of overlapping belts.
Figure 4. Composite diagrams for rocks of Holocene age from the Edgecumbe volcanic field (location shown on Fig. 5). A, AFM diagram after Irvine and Baragar (1971), non-tephra-deposit samples, data from J. R. Riehle (written communication, 1986). B, Silica-variation diagram, non-tephra-deposit samples, data from Brew and others (1969), Myers and Marsh (1981), and Kosco (1981). C, AFM diagram, tephra-deposit samples, data from J. R. Riehle (written communication, 1986). D, Silica-variation diagram, tephra-deposit samples, data from Riehle and Brew (1984).
Figure 5. Location map and composition diagrams for rocks of Holocene age. A, the Edgcambe volcanic field (A), southern Kupreanof volcanic field (B), Blue River-Unuk River volcanic field (C), Tlevak Strait field (D), and Behm Canal–Rudyard Bay volcanic fields (E). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. Data sources: Douglass and others (1989), R. L. Elliott (written communication, 1986), Wanek and Callahan (1971), and Ouderkirk (1982).

EXPLANATION
Rocks of late Oligocene and Miocene age from
- Icy Strait Belt
- Admiralty Island volcanic field

F=FeO+0.8998 Fe₂O₃
A=Na₂O+K₂O
M=MgO

0.8
0.6
0.4
0.2
P₂O₅

0.8
0.6
0.4
0.2
MgO

0.8
0.6
0.4
0.2
K₂O

0.8
0.6
0.4
0.2
CaO

0.8
0.6
0.4
0.2
Na₂O

0.8
0.6
0.4
0.2
Fe₂O₃

0.8
0.6
0.4
0.2
TiO₂

100
80
60
40
20
weight percent SiO₂

50
60
70
weight percent SiO₂
Figure 7. Chondrite-normalized rare-earth-element diagram for rocks of late Oligocene and Miocene age: Icy Strait belt (dots) and Admiralty Island volcanic field (circles). Data from D. A. Brew (unpublished data, 1985) and G. Pfafker (written communication, 1986).

originally a rift or an ocean between two different terranes, was
the movement of the outboard Alexander terrane (Silberling and
others, this volume) toward the northeast (Monger and others,
1982). This movement is interpreted to have preceded the con-
vergence of the Chugach terrane against the westward margin of
the Alexander terrane (Plafker and others, 1977 and this volume,
Chapter 12; Johnson and Karl, 1985). The consistent compo-
osition of the magmas argues for a deep and equilibrated source,
even though the preliminary data of Arth and others (1986) on
strontium initial ratios indicate possible derivation from continen-
tal source materials. This latter possibility can be used to sup-
port a within-plate-rift origin of the structural discontinuity that
localized the tonalite sill belt and the other nearby parallel features of
the southeastern Alaska coincident zone (Brew and Ford, 1985).

Coast Mountains belt

The linear Coast Mountains belt along the International
Boundary (Skagway/Ketchikan–Prince Rupert Coast Mountains
belt [55 to 45 Ma] on Fig. 3 and Tables 1 and 2) consists of a
large volume of early and middle Eocene plutons that are proba-
bly a result of the convergence and crustal thickening associ-
ated with the compressive event just described. These rocks are
consistently calc-alkalic, dominantly metaluminous north of the
Sumdum area, and exclusively moderately peraluminous to the
south. The overall range in silica content is 53 to 76 percent; the
average silica content is about 67 percent to the north of the
Sumdum area and 72 percent to the south. Modally, the rocks are
dominantly plagioclase-biotite granodiorite, granite, and
tonalite. Available age determinations indicate that the plutons in
the southern part of the Coast Mountains were emplaced between
55 and 45 Ma, and those in the northern part from 54 to 49 Ma.
The Coast Mountains belt of large composite plutons parallels the
great tonalite sill belt, commonly within a few kilometers, and in
several places intrudes that belt.

The differences in age, structural habit, and composition of
the rocks in this belt indicate a different origin from that of the
great tonalite sill belt. The general absence of all structures but
flow foliation, and the restricted thermal aureoles that are super-
posed on the earlier Barrovian-type metamorphism associated
with the tonalite sill belt, indicate that these early and middle
Eocene intrusions are post-tectonic and that their emplacement
followed the abrupt uplift that accompanied and closely followed
intrusion of the sill belt.

The composition of the plutons in the Coast Mountains belt,
their location in relation to the highly deformed and presumably
thickened crust near the tonalite sill belt, and the time-lag rela-
tions all indicate that the Coast Mountains belt is the result of
the thickening that occurred during the latest Cretaceous and early
Tertiary collision discussed above. I infer that the change from
metaluminous to moderately peraluminous composition from
north to south is related to the type of material conveyed to depth
in the convergent zone. This may be a result of the greater thick-
ness of older continental crust in the southern part of the Alex-
ander terrane compared with the northern part.

Figure 9. Chondrite-normalized rare-earth-element diagrams for rocks of
late Oligocene and Miocene age from the Klu-ketin volcanic-plutonic
belt. A. Basalts and andesites. B. Rhyolites (dots) and granitic rocks
Figure 10. Location map and composition diagrams for plutonic rocks of late Oligocene and Miocene age. A, the Kuiu-Etolin volcanic-plutonic belt (N) and Groundhog Basin area (O). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, General plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: Douglass and others (1989), and Hunt (1984).
Figure 11. Location map and composition diagrams for plutonic rocks of late Oligocene and Miocene age. A, the Quartz Hill/Portland Peninsula area (V). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram; D, general plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzonodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: Smith and others (1977); Hudson and others (1979).
Figure 12. Location map and composition diagrams for granitic and gabbroic rocks of middle and late Eocene and early Oligocene age. A, the Glacier Bay region (X) and the Yakobi, Chichagof, and Baranof area (Z). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, general plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzonodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: Himmelberg and Loney (1981), Himmelberg and others (1987), and Brew (unpublished data) for all but Baranof area; Waneck and Callahan (1969) and Callahan (1970) for Baranof area.
**Fairweather-Baranof belt**

Plutons of the Fairweather-Baranof belt and the Glacier Bay region (Fig. 3, Tables 1 and 2) were emplaced in the time span of late Eocene to early Oligocene (45 to 35 Ma). The Fairweather-Baranof belt is parallel to the Coast Mountains belt and approximately 200 km to the southwest. Emplacement ages of 49 to 39 Ma indicate that the Fairweather-Baranof belt is younger than the Coast Mountains belt, although there is some overlap. Biotite-hornblende tonalite and granodiorite are the most common rock types in the southern part of the Fairweather-Baranof belt, and gabbro-norite, pyroxenite, and other mafic and ultramafic rocks dominate the northern part. The granitic plutons are calc-alkaline, mostly peraluminous, and have silica contents that range from 60 to 73 percent. The belt occurs largely within the Chugach terrane (Silberling and others, this volume) and is interpreted to have formed as a result of the convergence and accretion of the Chugach terrane. Metamorphic mineral ages suggest that the convergence occurred in Late Cretaceous time, though before the time of the main deformation and metamorphism associated with the great tonalite sill belt.

In this interpretation, the Coast Mountains and the Fairweather-Baranof belts are not quite synchronous and are not directly related; either could have formed independently. The Coast Mountains belt is one result of the closure of the Gravina basin because of northeastward movement of the Alexander terrane, whereas the Fairweather-Baranof belt is one result of the
Figure 15. Location map and composition diagrams for granitic rocks of early and middle Eocene age. A, the Haines-Skagway area (AA). B, AFM diagram (Irvine and Baragar, 1971). C, Silicavariation diagram. D, General plutonic rock classification diagram (Streckeisen, 1973). AF, alkali-feldspar granite; AQF, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite, GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. FeO* indicates total Fe as FeO. Data source: Barker and others (1986).
Figure 16. Location map and composition diagrams for granitic rocks of early and middle Eocene age. A, the Juneau-Taku River area (BB). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, general plutonic rock classification diagram (Streckeisen, 1973): AF, Alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data source: D. A. Brew and A. B. Ford (unpublished data, 1985).
Figure 17. Location map and composition diagrams for granitic rocks of early and middle Eocene age. A, the Sumdum (CC) and Petersburg (DD) areas. B, AFM diagram (Irvine and Baragar, 1971). C, silica-variation diagram. D, General plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: D. A. Brew and A. B. Ford (unpublished data, 1985) for Sumdum; Douglass and others (1989) for Petersburg.
accretion of the Chugach terrane to the west side of the Alexander terrane.

**Glacier Bay region**

The Glacier Bay region (Fig. 3, Tables 1 and 2) is, in contrast to the magmatic belts described, a northeast-trending, nearly rectangular area that slightly overlaps the northern part of the Fairweather-Baranof belt geographically and also in time, with ages ranging from about 42 to 30 Ma. The calc-alkaline plutons are dominantly nonfoliated to weakly foliated, metaluminous and moderately peraluminous biotite granite and alkali granite. Silica values range from 58 to 76 percent. This group of plutons is areally, compositionally, chemically, and structurally distinct from those in the Fairweather-Baranof belt, and their origin, though linked to the latter, must differ in some significant way. One possibility is that the plutons of the Glacier Bay region represent the silicic remnant of a magmatic system that produced the dominantly gabbroic plutons in the adjacent northern part of the Fairweather-Baranof belt and that the emplacement of the silicic portion was displaced to the northeast by the previously emplaced less fractionated mafic and ultramafic bodies. Another possibility is that they are an early manifestation of the younger (35 to 5 Ma) Tkoro-Portland Peninsula belt, which itself is related to some obscure regime in the period after Chugach-terrane accretion and before transform faulting.

**Tkoro-Portland Peninsula belt**

The Tkoro-Portland Peninsula belt, the Groundhog Basin-Cone Mountain area, and the southern southeastern Alaska dike swarm (Fig. 3, Tables 1 and 2) were emplaced within the time span of late Oligocene and Miocene (35 to 5 Ma). The three belts are clearly different from the collision-related belts just described; they each have distinct petrologic characteristics and represent different types of magma-generating events.

The Tkoro-Portland Peninsula belt (Fig. 3, Tables 1 and 2) is the most prominent of the three belts or areas. It extends in a northwest-southeast direction for at least 560 km across all of southeastern Alaska, cutting across all tectonostatigraphic terranes except the Chugach terrane at an angle of about 15°. Both volcanic and plutonic rocks occur. The volcanic rocks are flows, tuff, and breccia of andesitic, basaltic, ryholitic, and dacitic composition. All are calc-alkaline, and silica contents range from 47 to 77 percent, with a significant gap at 61 to 66 percent. Available age determinations indicate that the volcanics were erupted during the period from about 25 to 16 Ma. The granitics are both calc-alkaline and alkaline. Granite and granite porphyry are the most common rock types at the ends of the belt; most are moderately peraluminous. Alkali granite, granite, quartz syenite, and alkali quartz syenite are common types in the central part. Leucogabbro and gabbronoroc occur locally. The plutonic rocks have a silica range of 49 to 77 percent with significant gaps at 54 to 56 and at 61 to 65 percent. The plutons were emplaced from 35 to 19 Ma:

![Figure 18. Chondrite-normalized rare-earth element diagram for granitic rocks of early and middle Eocene age from the Petersburg area. Data source: D. A. Brew (unpublished data, 1985).](image)

those at the northwest ends of the belt at about 28 to 24 Ma, those in the center at 24 to 19 Ma, and those at the southeast end at 30 Ma and 27 to 24 Ma.

The length and continuity of the Tkoro-Portland Peninsula belt suggest that it could be the result of a significant collisional event of unusual orientation. However, no other evidence supporting such an origin has been preserved, and thus it is here considered unlikely. The composition of the plutons is unlike those in the other magmatic belts, probably because the magmas were generated at the base of or within the continental crust of the Alexander/Stikine terranes. The cause of the magmatic events is probably related to the change from convergence to oblique subduction to strike-slip movement between the Pacific and North American Plates, but the actual mechanism that caused the long belt to form is not clear. The axis of the belt coincides with the orientation of the tension planes that would be associated with the onset of differential strike-slip movement along the continental margin. The slight change in orientation of the belt near its southeast end could be related to differences in the thickness of the crust.

**Groundhog Basin-Cone Mountain area**

The Groundhog Basin-Cone Mountain area includes rhyolitic sills and biotite granite plugs (Fig. 3, Tables 1 and 2). Alkali
Figure 19. Location map and composition diagrams for granitic rocks of early and middle Eocene age. A, Bradfield Canal (EE) and Ketchikan (FF) areas. B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, General plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: Webster (1984) and Smith (1977) for Bradfield Canal area; Smith (1977) for Ketchikan-Prince Rupert area.
Figure 20. Location map and composition diagrams for granitic rocks of Paleocene age. A, the Juneau-Skagway area (GG). B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, General plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data source: D. A. Brew and A. B. Ford (unpublished data, 1985).
Figure 21. Location map and composition diagrams for granitic rocks of latest Cretaceous age. A, the Haines-Skagway (HH) and Juneau-Taku River (II) areas. B, AFM diagram (Irvine and Baragar, 1971). C, Silica-variation diagram. D, General plutonic rock classification diagram (Strickler, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: D. A. Brew and A. B. Ford (unpublished data, 1985) and Barker and others (1986).
granites may be present in the Cone Mountain area, but available data indicate that the rocks are calc-alkalic and moderately peraluminous and have a silica content from 74 to 76 percent. The granites were intruded at about 16 Ma, later than the rocks in the Tkope–Portland Peninsula belt. The plutons were intruded at a high crustal level under static conditions, but their relations to other belts and to possible localizing factors are obscure.

Southern southeastern Alaska dike swarm

The southern southeastern Alaska dike swarm (Fig. 3, Tables 1 and 2) consists mostly of lamprophyres that occupy a significant part of a northeast-trending belt about 100 km wide. Coeval granitic and volcanic rocks are also present. The swarm overlaps the southeastern end of the Tkope–Portland Peninsula belt, and at least some of the dikes are closely related to the plutons there. The lamprophyres are alkalic, and most are classified as alkali-olivine rocks. The non-lamprophyres are calc-alkalic and have a silica content ranging from 56 to 71 percent.

The age of intrusion of the lamprophyres is not well known; they cut plutons with ages of 27 to 24 Ma in the Tkope–Portland Peninsula belt but are not known to cut the plutons of the Grounding Basin area with ages of 17 to 14 Ma. Souther (1970) interprets them as the deeper expression of the dated Miocene alkalic volcanic fields to the northeast in British Columbia. Souther infers that these fields are localized in belts of large-scale crustal extension related to continental-margin transcurrent faulting; the dikes follow joints that are perpendicular to the foliation of the country rocks and resulted from the relaxation of the major stresses that affected the Coast Mountains belt in earlier Tertiary time.

Kruzof-Kupreanof and Behm Canal–Rudyerd Bay areas

Two areas or belts of Pliocene and Quaternary volcanic rocks are shown on Figure 3 and described in Tables 1 and 2. One, the Kruzof-Kupreanof area of Holocene rocks, appears on Figure 3 as two segments separated at the Chatham Strait fault because it postdates the major offset that was removed in constructing the palinspastic base for the figure. This area consists of two widely spaced volcanic fields of similar age and chemical composition. Those fields—Edgecumbe and southern Kupreanof—contain tholeiitic basalt, and the Edgecumbe field also has calc-alkalic younger flows and pyroclastic rocks. Most, but not all, of the flows are interpreted (J. R. Riehl and D. A. Brew, unpublished data) to be postglacial. Together, the two fields define an east-west–trending area similar in orientation to east-west Holocene volcanic belts in the west-central British Columbia region, which Souther (1970) relates to large-scale crustal extension.

The other area of Pliocene and Quaternary volcanic rocks is the Behm Canal–Rudyerd Bay volcanic field, most of which occurs within the area covered by the southern southeastern Alaska dike swarm. The small Blue River–Unuk River volcanic

Figure 23. Location map and composition diagrams from granitic rocks of latest Cretaceous age. A. the Sumdum (JJ), Petersburg (KK), and Ketchikan–Prince Rupert (MM) areas. B. AFM diagram (Irvine and Baragar, 1971). C. Silica-variation diagram. D. General plutonic rock classification diagram (Streckeisen, 1973): AF, alkali-feldspar granite; AQ, alkali-feldspar quartz syenite; AS, alkali-feldspar quartz syenite; AS, alkali-feldspar syenite; DI, diorite; GR, granite; GD, granodiorite; MD, monzodiorite; MO, monzonite; QD, quartz diorite; QO, quartz monzodiorite; QM, quartz monzonite; QS, quartz syenite; SY, syenite; TO, tonalite. Data sources: D. A. Brew and A. B. Ford (unpublished data, 1985) and Brew and Grybeck (1984) for Sumdum; Douglass and others (1988) for Petersburg; and Smith (1977) for Ketchikan–Prince Rupert.
field to the north (Fig. 1) is here considered an outlier of the Behm Canal–Rudyard Bay field. Both fields contain alkali olivine basalts and other alkalic rocks that resemble the alkali to peralkaline basalts in the Mount Ediza field, which is located about 100 km to the north in Canada. Souther and Armstrong (1966), Souther (1970), and Souther and others (1984) relate the north-south orientation of the Mount Ediza field to large-scale crustal extension. It is likely that the Behm Canal–Rudyard Bay field is an outlier of that large field.

SUMMARY

The Cenozoic volcanic and plutonic rocks of southeastern Alaska record a progression of events that are related to the tectonics of the northeastern Pacific margin. The progression started with the collisional/convergent events related to the accretion of the Alexander terrane to the Stikine terrane; the progression continued with the events related to the accretion and subduction of the Chugach terrane on the west side of the Alexander. These events along the northeastern Pacific margin occurred in Late Cretaceous and early Tertiary time; they were followed by events related first to oblique subduction and then to transition to dominantly transient movements. The progression ended with magmatic events localized along extensional zones that may be related either to present-day right-lateral crustal displacements in the northeastern Pacific region or to residual stresses that originated in the late stages of convergence. Figure 24 summarizes these time and space relations.

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**Note:**

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NOTES ADDED IN PROOF

Most of the recent work that contributes to the subject of this chapter has been in the Coast Mountains and adjacent areas. That work consists mainly of the age-dating by G. E. Gehrels and coworkers, the detailed petrologic studies in the Juneau area by J. L. Drinkwater and coworkers, and the geochemical comparison of the Skagway and Ketchikan transects by F. Barker and J. G. Arth. In addition, D. A. Brew and coworkers are continuing studies of the Eocene plutons in the outer islands of southeastern Alaska and J. R. Riehle and coworkers have completed a series of reports on the Mount Edgecumbe volcanic field. References covering these and other studies follow.

ADDITIONAL REFERENCES


