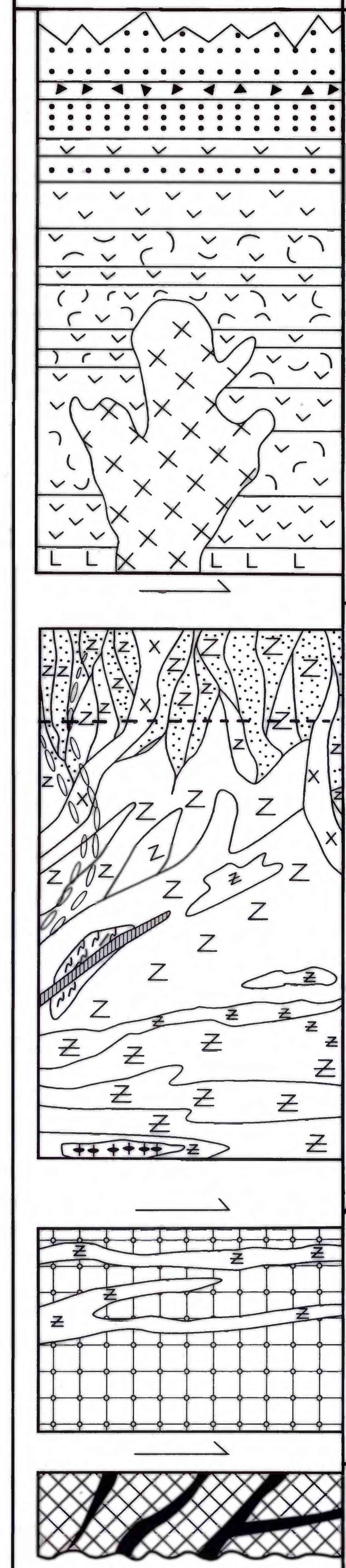
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
in cooperation with
ALASKA DIVISION OF GEOLOGICAL AND GEOPHYSICAL SURVEYS

A	B LITHOLOGY	C THICKNESS (EST.)	D AGE	E MINERAL DEPOSITS
	Volcanogenic and sedimentary unit: Andesitic, dacitic, and minor basaltic tuffs, tuff breccias, flows, flow breccias, and domes of the Talkeetna Formation. Interbedded siltstone, and shale, and volcaniclastic sandstone and conglomerate are also present, particularly in the upper sections. Base not clearly exposed. The Talkeetna Formation is intruded by quartz diorite and tonalite with minor granodiorite and trondhjemite. Plutons are Jurassic in age.	> 6 km (?)	Late Triassic-Early Jurassic age determinations for megafossils within sedimentary units (Imlay and Detterman, 1973; Detterman and Reed, 1980). K-Ar ages on intermediate plutonic rocks are 163 to 194 Ma (Hill, 1979; Winkler and others, 1981; Pavlis, 1982b; Burns and others, 1991).	Ag, Cu, Pb, Zn- Is interpreted to be the host rock for volcanogenic massive sulphide prospect (Johnson River) on the west side of Cook Inlet. Volcanogenic massive sulphide prospects in the Lake Clark quadrangle may be in the Talkeetna Formation. However, age control is poor, and the prospects may be in younger volcanic rocks (Newberry, pers. comm., 1990). Ag, minor Au - Geochemical indicators and subaerial volcanic rocks suggest that epithermal silver deposits may be present in the southern Talkeetna Mountains (Newberry, pers. comm., 1990).
	Sheeted dike complex: Composed of multiple intrusions (1 cm to 2 m thick) of diabase, gabbronorite, hornblende pyroxene gabbronorite, hornblende gabbro, and quartz diorite.	1 km (?)		No deposits reported
	Massive gabbroic complex: Chiefly gabbronorite, leucogabbronorite, magnetite gabbronorite, and hornblende pyroxene gabbronorite. Intrudes amphibolite, schist, and minor marble; protolith of the metamorphic rocks is interpreted to be dominantly mafic volcanic rocks, metachert, and minor impure limestones. These metamorphic rocks are also intruded by quartz diorites and trondhjemites.	4 km	K-Ar dates on hornblende from gabbroic rocks range from 154 to 188 Ma (Winkler and others, 1981) and are interpreted to represent cooling ages of young phases. Quartz diorite ages as given above. K-Ar ages on biotite, hornblende, and muscovite from the tonalite-trondhjemite suite are 135 to 110 Ma (Pavlis, 1983: Winkler, 1989). A zircon age is 103 Ma (Winkler, unpub. data). Permian age fusulinids were found in a marble near the Eklutna complex (Clark, 1972a); the marble may be correlative with the metavolcanic and metasedimentary rocks intruded by the gabbroic rocks.	Cu- A few small magmatic copper prospects are known in the gabbroic rocks.
	Lineated, layered gabbroic complex: Chiefly gabbronorite, leucogabbronorite, thin layers of anorthosite; garnet-bearing layers locally. Includes rare pods of dunite, clinopyroxenite in Nelchina River Gabbronorite. Intruded by narrow clinopyroxenite and later websterite dikes in the Tonsina area.			
	Cumulate ultramafic complex: Eklutna: Thick sequence of partly serpentinized chromite-bearing dunite at base, with progressively more wehrlite and clinopyroxenite up section. Minor websterite. Gabbronorites interlayered with clinopyroxenites near top. Red Mountain: Klippe composed of thick section of dunite, chromitite, and subordinate clinopyroxenite. Local garnet clinopyroxenite. Klippe rests on McHugh Complex. Wolverine: Thin layers (fault slices?) of dunite, clinopyroxenite, wehrlite, altered gabbronorite; extremely faulted, tectonized area (Burns and others, 1991).	2 km	No age data	Cr- Wolverine complex - Chromite bands and stringers up to 8 cm thick occur in dunite and minor wehrlite. The west zone the complex grades 10 to 20% Cr. The east zone has a grade or 10 to 15% Cr (Foley and Barker, 1985; Newberry, 1986). Cr- Eklutna complex- An estimated 1000 st Cr_2O_3 in segregations of disseminated and banded chromite within serpentinized dunite (Foley and Barker, 1985). Cr- Red Mountain- Podiform chromite deposits in dunite and wehrlite. Reserve estimates include 1.6 million st of contained Cr_2O_3 (Foley and Barker, 1985).
	Tectonized ultramafic complex: Tonsina: Harzburgitic dunite and dunite intruded by websterite and clinopyroxenite dikes. Wolverine: Minor amounts of badly deformed harzburgite.	0.5 km (?)	No age data	Cr- Bernard Mountain- Three exposed deposits at Bernard Mountain contain identified resources equal to 343,000 tons of Cr_2O_3. Each deposit consists of numerous, thin lenses or bands of chromite up to several inches thick in dunite gangue. Chromite also occurs as disseminated grains ranging from 0.1 to 2 mm (Foley and Barker, 1985).

EXPLANATION

- Volcaniclastic sedimentary rocks, including mainly graywacke, sandstone, mudstone, and subordinate conglomerate
- Hyaloclastite
- Tuff, tuff breccia, ignimbritic tuff
- Andesite
- Basalt
- Trondhjemite-tonalite dikes and pluton
- Quartz diorite, tonalite, minor granodiorite
- Hornblende diabase dikes, boudinaged and partially assimilated by quartz diorite and gabbroic rocks
- Plutonic dike complex composed of hornblende gabbro, pyroxene hornblende gabbronorite, magnetite gabbronorite, gabbronorite, diabase, and quartz diorite
- Metasomatized gabbroic rocks which contain abundant hornblende, chlorite, epidote, and magnetite
- Inclusions of amphibolite, schist, and minor marble
- Gabbronorite and magnetite gabbronorite - massive
- Gabbronorite, magnetite gabbronorite, leucogabbronorite, and anorthosite - foliated
- Dunite, wehrlite, clinopyroxenite, and minor websterite
- Veins of clinopyroxenite, orthopyroxenite and websterite
- Harzburgitic dunite and harzburgite

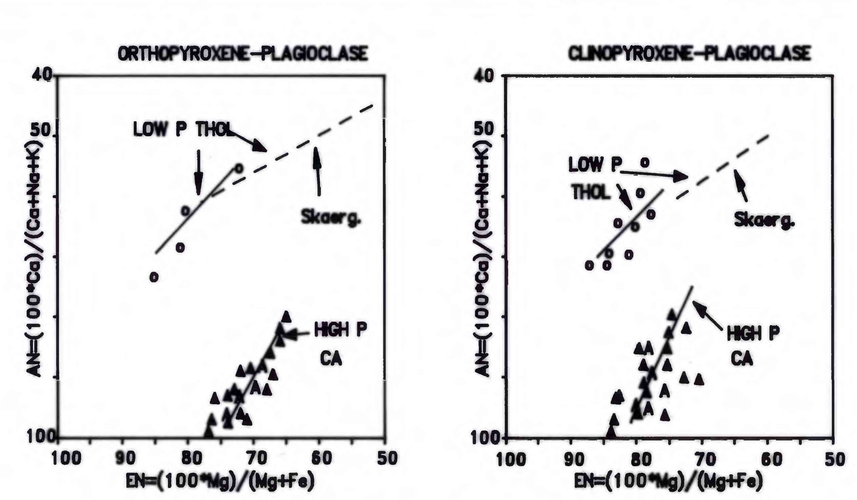


Fig. 7: Compositional pairing for coexisting mineral pairs from plutonic rocks from the Border Ranges complex: a) orthopyroxene-plagioclase, and b) clinopyroxene-plagioclase. Symbols include: o - plutonic inclusions in oceanic rocks; A - plutonic inclusions in island arc rocks; ▲- Border Ranges complex. Differentiation trends shown are low pressure tholeiitic trends (LOW P THOL), which include Skaergaard and a trend deduced from published analyses of gabbroic inclusions in oceanic basalts; the high pressure calc-alkaline trend (HIGH P CA) is determined from published analyses of gabbroic inclusions in magmatic arc volcanic rocks. Figure modified from Burns (1985).

F COMPOSITIONAL DATA

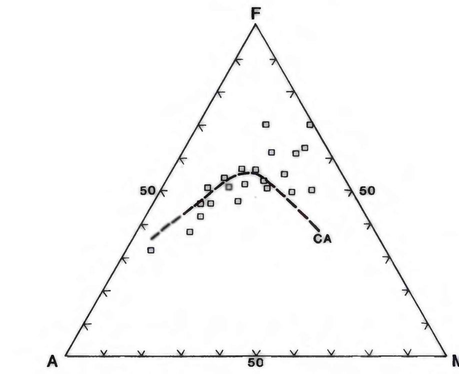


Fig. 1: AFM diagram for Talkeetna Formation volcanic rocks. Calc-alkaline trend (CA) taken from Irvine and Barager (1971). Data from Burns and others (1991).

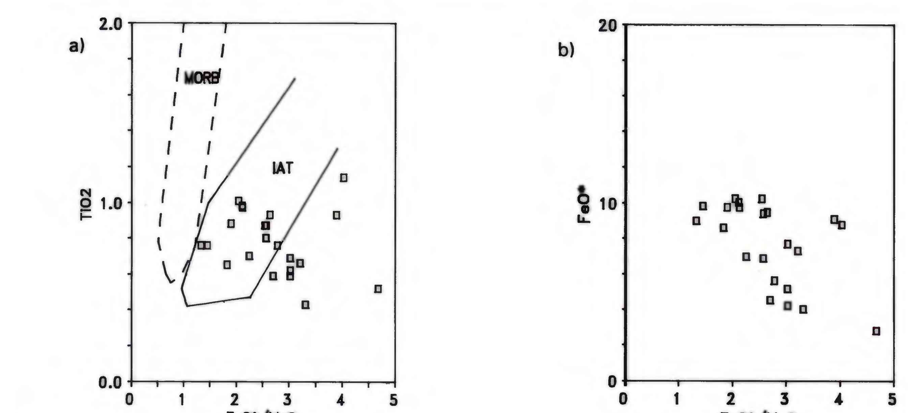


Fig. 2: FeO^*/MgO diagrams for Talkeetna Formation volcanic rocks showing a) TiO_2 and b) FeO^*. MORB (mid-ocean ridge basalt) and IAT (island-arc tholeiite) fields from Hawkins and Evans (1983). Data from Burns and others (1991).

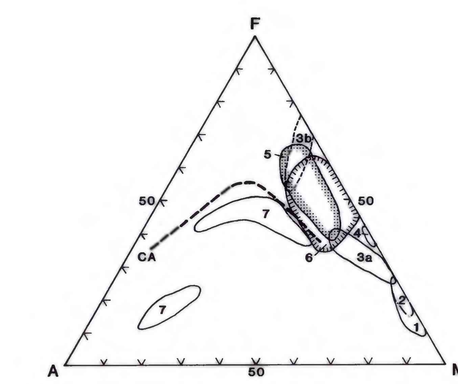


Fig. 3: AFM diagram for ultramafic, gabbroic, quartz dioritic, and trondhjemitic rocks. Calc-alkaline trend (CA) taken from Irvine and Barager (1971). Fields and sources of data summarized in figure 5 below.

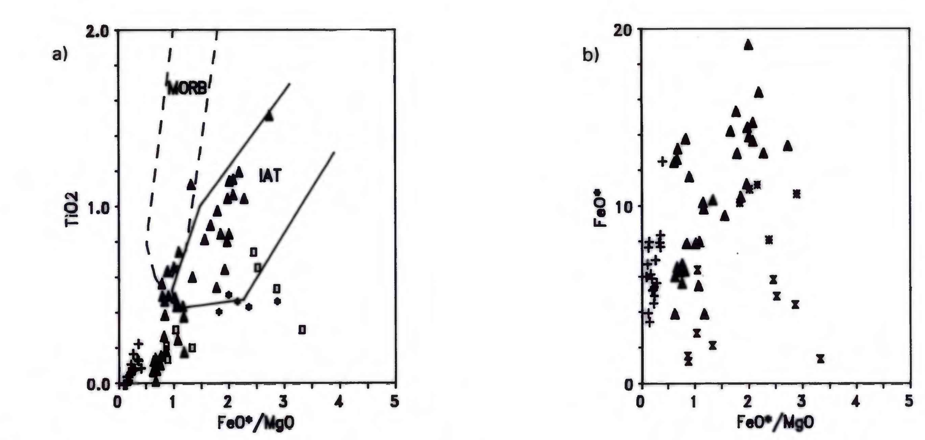


Fig. 4: FeO^*/MgO diagrams for plutonic rocks showing a) TiO_2 and b) FeO^*. MORB (mid-ocean ridge basalt) AND IAT (island-arc tholeiite) fields from Hawkins and Evans (1983). Data from Burns and others (1991).

- ⧗ Quartz diorites, tonalites, trondhjemites
- ✱ Mafic dikes
- ▲ Gabbroic rocks
- + Ultramafic rocks

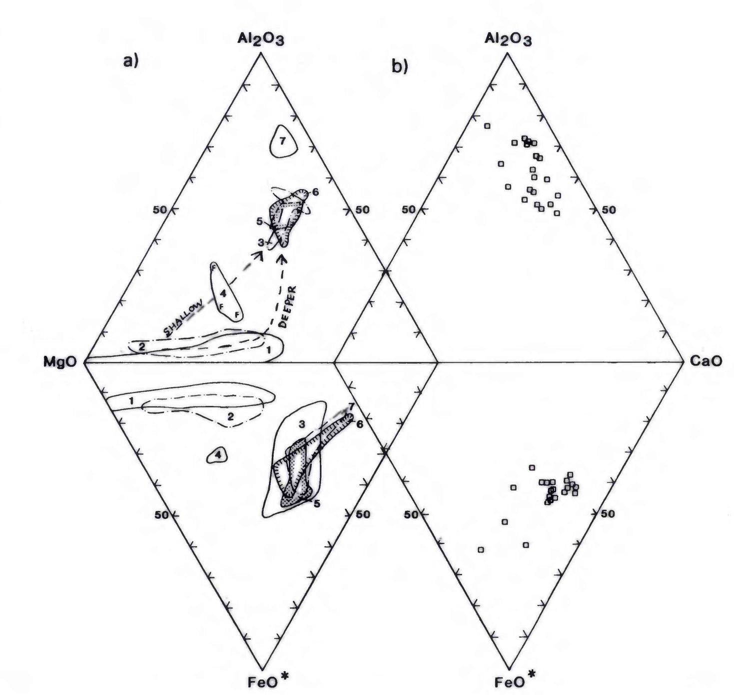


Fig. 5: MgO-CaO-Al_2O_3 and MgO-FeO^*-CaO diagrams for plutonic (see numbers below for fields) and volcanic rocks (symbol ▫). "Deeper" and "shallower" crystallization trends based on rock compositions, field work, and experimental data such as Green and Ringwood (1967) and Elthon and others (1982).

1. Cumulate dunite, wehrlite, and clinopyroxenite - Red Mountain, Kenai Peninsula. Data from Toth (1981).
2. Cumulate dunite, wehrlite and clinopyroxenite - Kodiak Island. Data from Beyer (1980).
3. Gabbronorites and basaltic dikes - Kodiak Island. 3a) Gabbronorites only. 3b) Basaltic dikes only. Data from Beyer (1980).
4. Small body of feldspathic wehrlite - Kodiak Island. F - denotes analyses. Data from Beyer (1980).
5. Gabbronorites - Nelchina River Gabbronorite. Data from Burns (1983), Burns and others (1991).
6. Plutonic dike complex: gabbronorites, hornblende gabbros, diorite - northcentral Chugach Mountains. Data from Burns (1983), Burns and others (1991).
7. Quartz diorites, tonalites, and trondhjemites mixed with upper level gabbronorites - northcentral Chugach Mountains. Data from Burns (1983), Burns and others (1991).

CLINOPYROXENE COMPOSITIONS

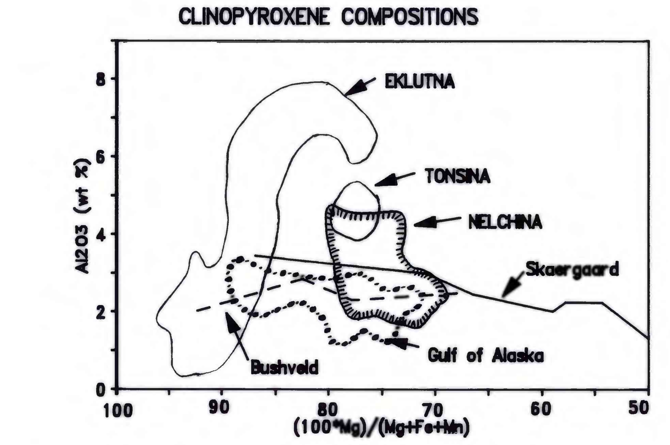


Fig. 6: Clinopyroxene compositional data shown from the Border Ranges ultramafic-mafic complex include gabbroic rocks from the Nelchina River Gabbronorite and the Tonsina body, and from ultramafic rocks from the Eklutna complex. Border Ranges data from Burns (1983), Burns (unpub. data). Skaergaard and Bushveld trends from Medaris (1972). Gulf of Alaska analyses (writ. comm., R.J. Newberry) for rocks which were provided by S.W. Nelson.

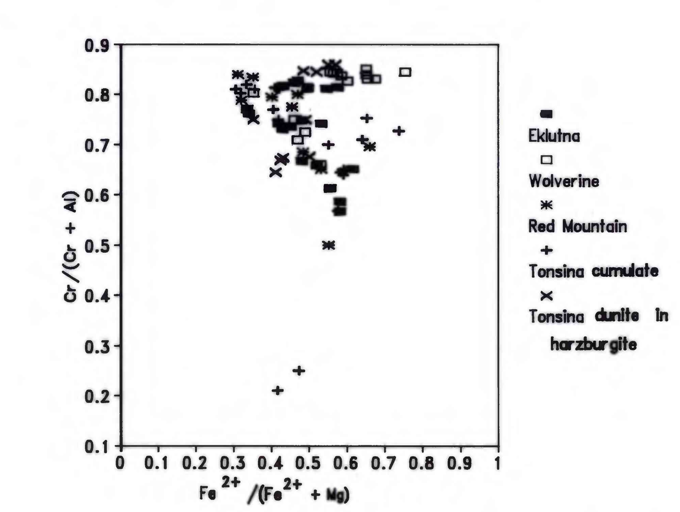


Fig. 8: Spinel compositions from the Border Ranges ultramafic-mafic complex. Figure modified from Burns (1985).

G GEOLOGIC SETTING

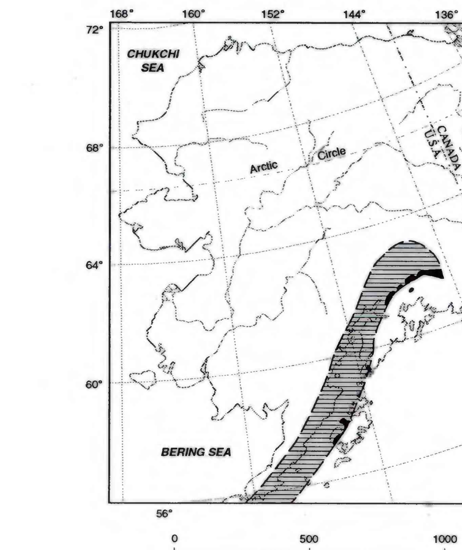


Fig. 9: The Peninsular terrane of Jones and others (1981), consisting of arc volcanic rocks and Jurassic plutonic rocks of intermediate composition is shown by horizontal lines. The Border Ranges ultramafic/mafic complex exposed near the southern and south-eastern borders of that terrane is shown in solid black and is interpreted by Burns (1985) to be genetically related to Jurassic arc volcanic rocks.

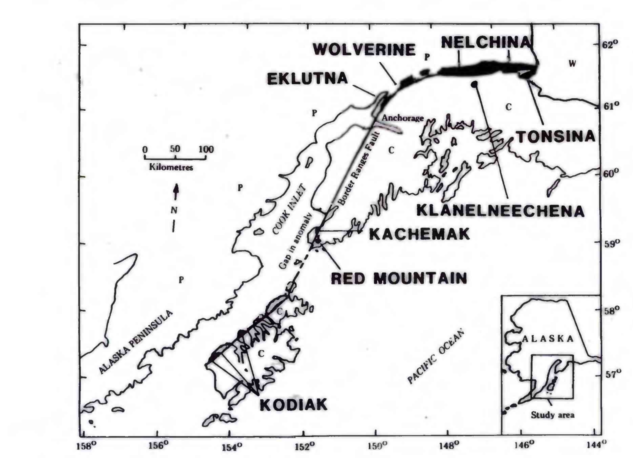


Fig. 10: Locations of the Border Ranges fault and major parts of the ophiolitic plutonic belt, shown in black. Terranes designators include 'P' (Peninsular), 'C' (Chugach and Prince William), and 'W' (Wrangellia). Modified from Burns (1985).

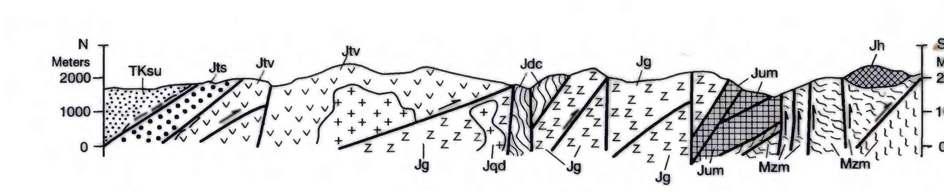


Fig. 11: Schematic cross section of the ophiolitic rocks of the northern Chugach Mountains

EXPLANATION

- TKsu - Sedimentary rocks (Tertiary and Cretaceous)
- Mzm - McHugh Complex - Extremely deformed greenstones and cherts (Mesozoic)
- Jtv - Talkeetna Formation volcanic rocks (Jurassic)
- Jts - Talkeetna Formation sedimentary rocks (Jurassic)
- Jqd - Quartz diorite, tonalite (Jurassic)
- Jdc - Plutonic dike complex composed of quartz diorite, hornblende gabbro, pyroxene hornblende gabbronorite, gabbronorite, and diabase (Jurassic)
- Jg - Gabbronorite and magnetite gabbronorite with subordinate pyroxene hornblende gabbronorite and anorthosite (Jurassic)
- Jum - Dunite, wehrlite, clinopyroxene, and minor websterite (Jurassic)
- Jh - Harzburgitic dunite and harzburgite (Jurassic)

OPHIOLITIC COMPLEXES NEAR THE BORDER RANGES FAULT ZONE, SOUTHCENTRAL ALASKA

BY
LAUREL E. BURNS

1992