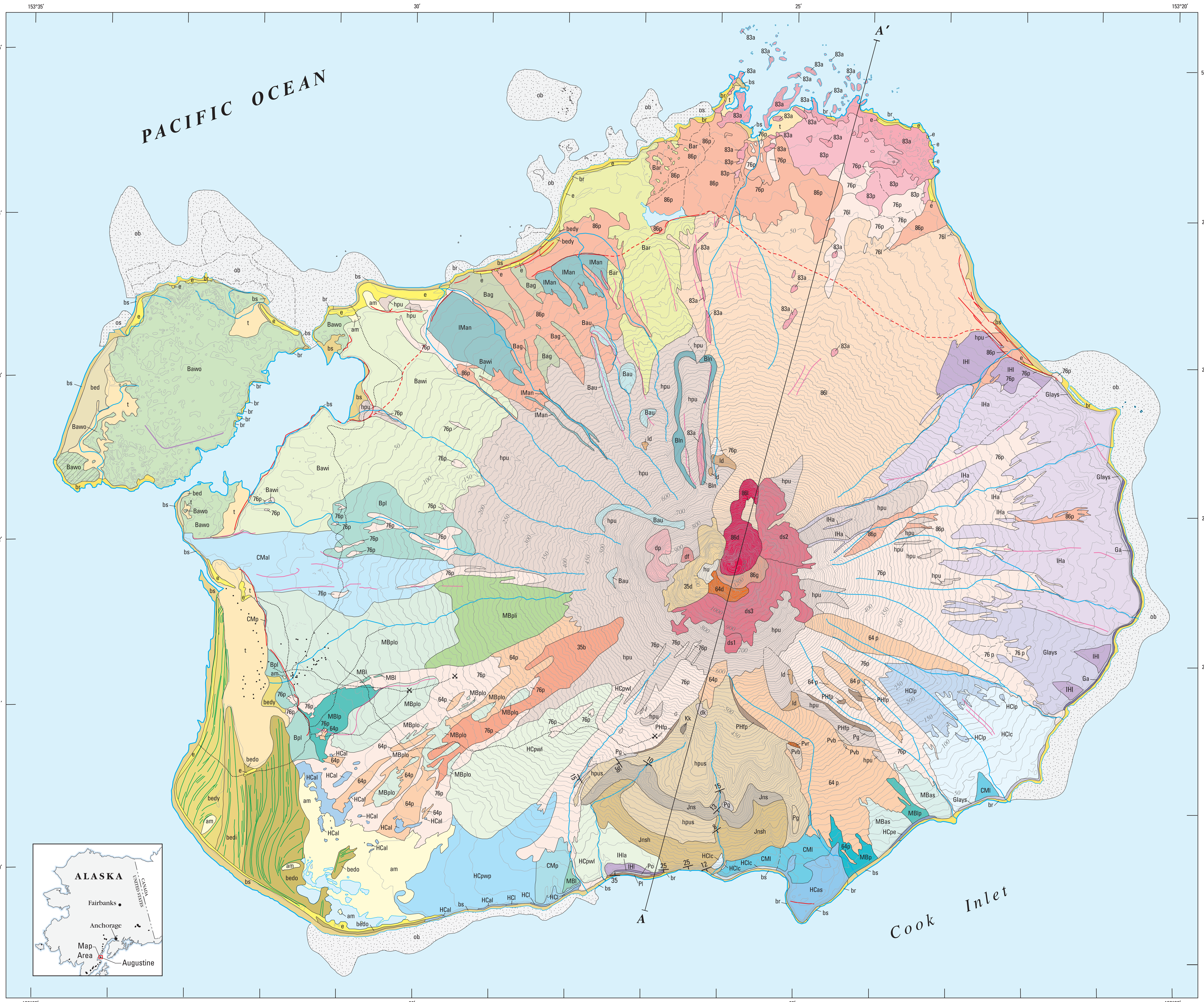
U.S. Department of the Interior
U.S. Geological Survey



Topography by photogrammetric methods from aerial photographs taken 14 August 1990. Topography and hydrology scribed in 1991 on Kern PG-1 stereoplotter and automatic table by Dan Turkington, USGS National Mapping Division, Cascades Volcano Observatory, Vancouver, Washington

1927 North American Datum

TRUE NORTH / MAGNETIC NORTH, 17½°. APPROXIMATE MEAN DECLINATION AT CENTER OF MAP, 2009

SCALE 1:25,000

1 .5 0 1 2 KILOMETERS

½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 FEET

CONTOUR INTERVAL 10 METERS
National Geodetic Vertical Datum of 1929

Shoreline is arbitrary, sea level at time air photos were taken. Shoreline represents an intermediate level below mean high water and above mean low water, probably closer to the latter.

Geology field-mapped 1988–1995 by Richard B. Waitt

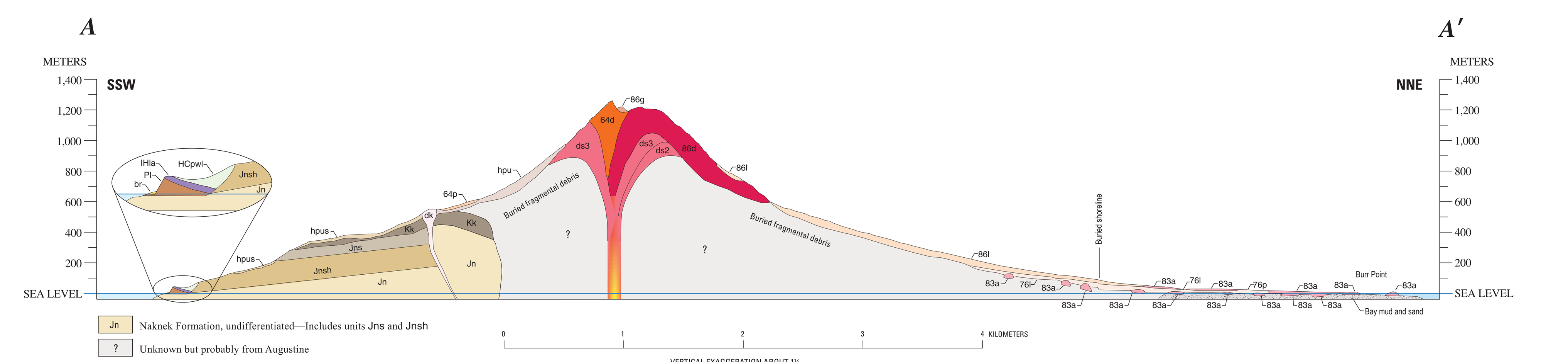
Geologic map compiled 1994–1999 by Richard B. Waitt on Kern PG-2 stereoplotter

Analog topographic, hydrologic, and geologic maps converted to combined Arc/Info digital map by Jacqueline McIntire in 1999–2006

Final map prepared in Adobe Illustrator by Christine G. Janda in 2007-2008

EXPLANATION

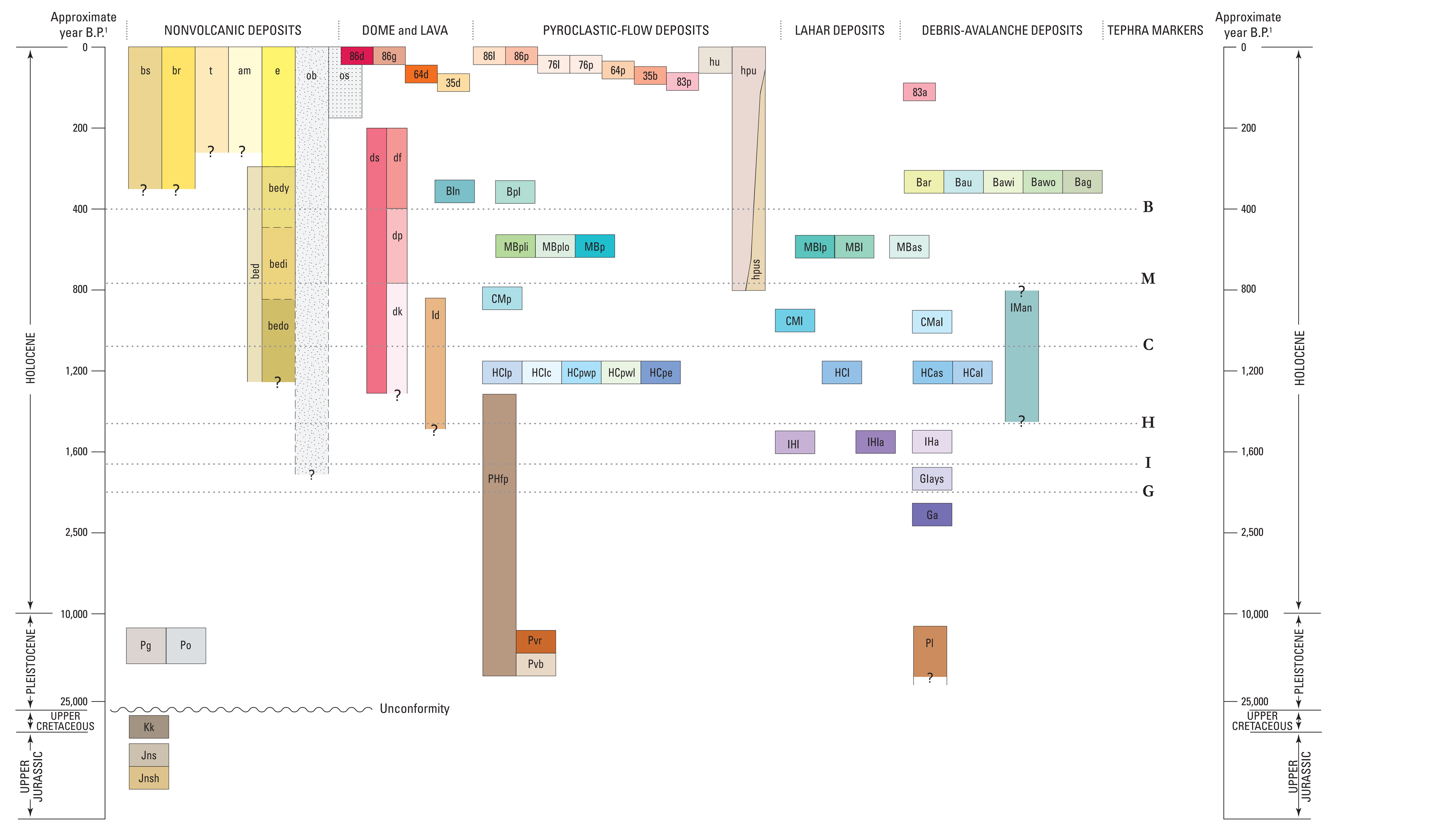
- **Contact**—No contact where boundary is gradational and arbitrary
- **Internal contact**—Delineates boundaries of separate flow deposits obvious in the field, like steep outer margins of a pumiceous pyroclastic flow within units 76l and 86p
- **Levees at margins of debris avalanches**
- **Linear south edge to central core of high hummocks on West Island**
- **Beach ridges**—Except near coast, thickly mantled by eolian sand and tephra
- **Partially buried shoreline**—Old, mostly prehistoric shorelines. Dashed where thoroughly covered by younger deposits
- **Tsunami-flattened hummock**
- **Isolated large boulders**—In West Lagoon, a lag
- 25 **Strike and dip of bedrock**—Value is dip of bedding in degrees
- **Bulldozer tracks**—Made in 1950s
- **Pumice pit**—Made in 1950s; mostly covered by 1976 flows



Jn — Naknek Formation, undifferentiated—Includes units Jns and Jnsh

? — Unknown but probably from Augustine

CORRELATION OF MAP UNITS



¹Pleistocene and Holocene ages in uncalibrated radiocarbon time

DESCRIPTION OF MAP UNITS

Most map units are divided by age, which in prehistoric deposits is determined largely by presence of overlying marker beds in the form of coarse pumiceous tephra layers (fall deposits). These tephra layers are designated in ascending stratigraphic order: G, I, H, C, M, and B. All are late Holocene age by radiocarbon dating (table 2). Prehistoric volcanic deposits are designated in time by the tephra layers they lie between. Thus, unit HCas lies above tephra layer H and below tephra layer C. Prehistoric units that are older than tephra G or younger than tephra B are designated by the one tephra symbol, such as units Ga and Bar.

Age of historic deposits is inferred from the absence of any of these beds and from various historic records, especially aerial photographs. Historic deposits are designated by the last two digits of the eruption year, thus unit 83a belongs to the 1883 eruption and unit 76p to the 1976 eruption.

Informal names: On Augustine Island most geographic names—like West Island, Southeast Point, and North Bench—are informal and most properly written in lower case. They are capitalized only for clarity in the reading. To distinguish formal from informal names, please see figure 1*B*.

Radiocarbon dates in titles and on correlation chart, as in main text and the tables, are in raw (uncalibrated) radiocarbon time.

Centered headings do not appear on correlation chart.

RECENT TO PREHISTORIC DEPOSITS (HOLOCENE)

Beach deposits—Divided into:

bs **Sandy**—Beach deposits consisting mostly of moderately sorted loose medium sand to small-pebble gravel lying in tidal zone of about 7 m

br **Rocky**—Beach deposits consisting mostly of boulders, generally smaller than 2 m but in several places as large as 7 m in intermediate diameter and many also in cobble range. Most boulders and cobbles derive from debris-avalanche or pyroclastic deposits exposed in a seacliff at back of beach

t **Tidal-flat and salt-marsh deposits**—Flat expanses of sand, gravelly sand, and sandy gravel winnowed from adjacent deposits and frequently covered at medium to high tide in areas that seaward deposits defend against surf

am **Marsh and pond alluvium**—Flat expanses of mud and sand in and along marshes and ponds on southwest part of island behind coastal deposits

e **Eolian sand**—Loose, well-sorted medium to coarse sand forming coastwise ridge at back of beach above high-tide level. In places includes interbedded ash layers or peaty layers. In places includes identical underlying prehistoric deposits. In a few places, especially on southwest coast, is continuous downsection into older eolian sand of unit bed and its subunits

Offshore deposits—Divided into:

ob **Boulders**—Fields of angular boulders of porphyritic andesite, some of them >4 m in diameter, extending variously 0.2 to 1.5 km offshore. Many visible at low tides, and on aerial photographs expressed as conspicuous dark areas beneath the sea. Derived from coarse fragmental deposits of various ages. Seaward "contacts" delineate only where these deposits become too deep below sea level to show on aerial photographs or at lowest tides

os **Sand**—Banks of sand lacking boulders

DEPOSITS AND FLOWS OF HISTORIC ERUPTIONS (HOLOCENE)

Products of 1986 eruption—Divided into:

86d **Lava dome**—Very dark gray (5YR 3/1)[1] to reddish porphyritic, microvescicular andesite containing about 20 percent plagioclase phenocrysts as large as 5 mm. Includes assimilated remnants of dome that had grown at same site in 1976. Geomorphically distinct north part of summit-dome complex (in 2006, covered and adsorbed within new 2006 dome)

[1] Munsell® colors and color names specified for a few units, estimated in field to nearest color chip of Munsell® Soil Color Charts (1975 version), Kollmorgen Corp., Baltimore, Maryland

Photograph by Richard B. Waitt, 29 June 1988

86g **Dome agglutinate and proximal-fall deposit**—Rampart composed of weakly welded clasts of porphyritic andesite, not present in photographs before 1986 eruption. A possible remnant (unmapped) of underlying 1976 dome consists of microvesicular gray (N 6/0) highly porphyritic andesite containing about 30 percent plagioclase phenocrysts as large as 4 mm (in 2006, covered and adsorbed within new 2006 dome)

86l **Deposits of lithic pyroclastic flow**—Lithic pyroclastic-flow deposits of large fan on north flank heading at dome (86d). Consist mostly of fragments of porphyritic andesite dome rock but can have 0–30 percent pumice. Some large lithic blocks exceed 4 m in diameter. Overlaps pumiceous pyroclastic-flow deposit downslope

86p **Deposits of pumiceous pyroclastic flow, mixed flow, and lahar**—Gravelly sand in which pumice clasts, as large as 1 m but typically 10–25 cm, range from white to gray to brownish gray and contain 5–10 percent inconspicuous plagioclase phenocrysts and some pumice clasts conspicuously banded; some have "breadcrust" surface texture. Contains as much as one-third angular lithic clasts generally smaller than 80 cm but in places including rare boulders as large as 2–4 m. Pumiceous flows have local surface relief as much as 1 m and steep margins 0.1 to 3 m high in digitate lobes, some as small as 3–10 m across; some flows have lateral levees 0.5–3 m high. Overlapped upslope by lithic pyroclastic-flow deposits. Deposits are mostly gravelly sand; pumice boulders are concentrated at surface. In years 1988–1993 vegetated only by a few sprigs of grass, blueberry, and moss.

Gravel lahar deposits grade downslope from pumiceous pyroclastic-flow deposit; range from matrix supported (debris-flow deposit) to openwork (flood deposit)

Products of 1976 eruption—Divided into:

76l **Deposits of lithic pyroclastic flow**—Patch on lower north-northeast flank similar to unit 76p but shed from 1976 dome and so contains little or no pumice. Nearly buried by units 86p and 86l

76p **Deposits of pyroclastic flow and lahar**—Similar to such flows of 1986 (see above) but are especially rich (as much as 40 percent) in banded brown-gray-white pumice clasts. Comprises several separate flows; internal contacts indicate flow fronts. Lithic clasts of andesite (and locally of sandstone) as large as 1.4 m. In 1988–1993 had many clumps of grass, blueberry, and moss, 1 to 2 orders of magnitude more vegetation than on similar 1986 deposits but still very sparse (less than 5 percent of surface covered). In places such as lower west-southwest swale, braided deposit veneers similar deposit of 1964 (and 1935?) more intricately than can be shown on map

Products of 1963–64 eruption—Divided into:

64d **Lava dome**—Gray (N 5/0) to reddish porphyritic andesite containing about 15 percent plagioclase phenocrysts as large as 3 mm. It is slightly microvesicular. Forms geomorphically distinct south rim (including summit) of summit-dome complex

64p **Deposits of pyroclastic flow and lahar**—Similar to pumiceous pyroclastic-flow deposit of 1986 and 1976 but much richer in lithic component and carrying larger lithic boulders. In places angular lithic boulders 0.5 to 2 m in diameter form much of surface, rare boulders are as large as 4 m. Internal lateral levees are common, some as high as 4 m. Deposits form broad paths leading nearly from base of dome to within 0.2 to 1.3 km of the coast. In contrast to younger (1986 and 1976) deposits, these (in 1991–1995) are caked with moss and a few alder are established. Deposits in west-southwest swale may be partly of 1935 eruption

Products of 1935 eruption—Divided into:

35d **Lava dome**—Gray (N 5/0) to reddish porphyritic andesite with 15 percent plagioclase phenocrysts as large as 4 mm and a few dark rounded, finely crystalline xenoliths. Forms geomorphically distinct northwest part of summit dome complex and a western lobe

35b **Blocky rubble**—Coarse bouldery rubble in form of fan shed from summit dome. Perhaps partly of 1964 dome collapses

Products of 1883 eruption—Divided into:

83p **Pyroclastic-flow and pyroclastic-surge deposits**—Massive poorly sorted lithic granular medium sand 0.3 to 2 m thick containing pebbles to 3 cm. Locally cut by upward-tapering fines-poor (gas-escape) pipes of small-pebble gravel. Capped by 10–20 cm of massive moderately sorted very fine sand to silt ash. Smooth surfaced, this deposit overlies debris-avalanche deposit back from Burr Point, partly filling lows between hummocks. Overlapped in many places by 1976 and 1986 pyroclastic-flow deposits, which where thin and discontinuous have arbitrary contacts with unit 83p. Internal contact on northeast indicates a flow front

83a **Debris-avalanche deposit**—Bouldery diamict including nearly intact but highly fractured blocks as large as 8 m in intermediate diameter (one is 25 m long!) and unfractured ones as large as 4 m. Matrix is sandy gravel of identical but finer-grained angular material. Jointing patterns are diversely irregular, platy, and columnar; rare blocks are of sintered spatter. Rare hummocks contain lenses of rounded pumice, apparently smeared-out clasts of pre-eruption pyroclastic-flow deposit. Rare hummocks contain yellow to brown blocks of soft and clayey, highly altered andesite. Whole deposit is hummocky: individual hummocks as high as 30 m and with basal diameter as much as 200 m, but typically 3–15 m high with basal diameters 20–80 m; some hummocks are arranged in curving arms. West side of deposit is marked by conspicuous nearly straight levee descending from 650 to 40 m altitude. Hummocky deposit is locally overlain by as much as 10 cm of eolian sand and peat containing distinctive white-silt fall ash as thick as 3 cm of Katmai 1912 eruption. Near the outer margins of overlapping 1976 and 1986 pyroclastic-flow deposits, ash-cloud silt overlies hummocky deposit

Grouped pyroclastic and laharic deposits—Divided into:

hu **Deposits of historic eruptions**—Muddy fall deposits (and pyroclastic-flow deposits?) of historic eruptions, nestled among 1935 and 1964 domes in summit area

hpu **Pyroclastic-flow and lahar deposits of historic and prehistoric(?) eruptions**—Pumiceous to lithic coarse rubble on steep (18–25?) upper- to middle-level slopes descending from base of summit-dome complex. Variable surface and indefinite stratigraphy but apparently swept repeatedly. Insufficient evidence (capping tephra, vegetative cover, morphology) to differentiate systematically by age. Includes a few patches of flowage and fall deposits of indeterminate age on lower flanks

hpus **Smooth slopes**—Smooth-surfaced slopes on south covered by prehistoric pumiceous falls and perhaps flows but not by coarse rubble flows characteristic of most areas mapped as hpu swept by flows from summit during historic eruptions. Probably essentially Jurassic-Cretaceous bedrock but thickly veneered by Augustine debris

PREHISTORIC HOLOCENE DEPOSITS AND FLOWS

bed (bedy, bedi, bedo) **Beach and eolian deposits**—Area of about 1.5 km² on southwest coast of well-sorted, loose, medium to coarse sand arranged in long, linear, subparallel, coastwise ridges. In deepest and most coastal excavations, sand overlies cobble gravel of subrounded to rounded stones of porphyritic andesite. Central and eastern (farthest inland) sand ridges enclose B(?) and M(?) tephras variously at depths of 0.4 to 5 m; western (near-coast) ridges are thinner and contain neither B nor M tephra. Cartographically divided into older, intermediate, and younger phases (units bedo, bedi, and bedy, respectively). Near present coasts passes upward into unit e

Deposits younger than B tephra (<370 ^{14}C yr B.P.)

Bln **North Slope lava flow**—Massive porphyritic andesite ranging from light gray (10YR 7/1) to oxidized light reddish brown (5YR 6/3); about 10 percent plagioclase phenocrysts as long as 4 mm. East side overlain by coarse debris-avalanche levee (unit 83a) as thick as 15 m

Bar **Rocky Point debris-avalanche deposit**—Bouldery nonsorted diamict including blocks as large as 5 m. Matrix is sandy gravel of identical angular, finer-grained material. Upper 1 m of a few hummocks shows schlieren of highly altered andesite. Whole deposit is hummocky like nearby Burr Point deposit (unit 83a). On east and southeast parts, hummocks overlain by as much as 30 cm of pyroclastic debris from 1883?, 1976, and 1986 eruptions. On north side against beach, some hummocks are overlain by eolian sand capped by the Katmai 1912 ash and at least one (1883?) older ash

Bpl **Lithic pyroclastic-flow deposit (or lahar deposit?)**—Bouldery diamict including blocks as large as 2 m. Matrix is sandy gravel of identical but finer-grained angular material. Has leveed, lobate form but heavily vegetated. Overlaps unit Bawi downslope

Bau **Undifferentiated small debris-avalanche deposits**—Bouldery diamict of porphyritic andesite including blocks commonly as large as 6 m, rarely as large as 15 m. Matrix is finer-grained nonsorted diamict of angular clasts. Forms several small lobes on north slope that did not reach below altitude 60 m. Most likely affiliated with events that formed west-island or rocky-point deposits

West Island debris-avalanche deposit—Divided into:

Bawi **Inboard facies**—Bouldery diamict similar to unit Bawo but with less local relief, thus much smaller, less distinct, and continuous hummocks. Apparently an irregular, thick veneer over older deposits that had been cut back into coastal sea cliff. Upslope locally underlain by M(?) tephra

Bawo **Outboard facies**—Bouldery diamict including blocks as large as 4 m. Matrix is sandy gravel of identical finer-grained angular material. Whole deposit is hummocky, the hummocks as high as 30 m with irregular basal diameter as much as 200 m, but typically 3–15 m high with basal diameters 20–80 m. In places directly overlain by gravelly sand pyroclastic-surge(?) deposit. Southwestmost hummocks (hachured area) have flattened tops overlain by patchy poorly sorted sand and capped by lag of 0.5- to 4-m boulders

Bag **Grouse Point tongue**—Bouldery diamict of angular blocks as large as 2.5 m. Matrix is sandy gravel of identical but finer-grained angular material, a nonsorted diamict of andesite clasts. Deposit is hummocky with relief as high as 5 m. Overlain by gravelly sand containing angular andesite cobbles and at least six fine-ash layers including two below Katmai 1912 ash. Unit could be an independent small debris avalanche similar in age to Bawo

Deposits between M and B tephras (about 750–370 ^{14}C yr B.P.)

Lithic pyroclastic-flow or lahar? deposit—Divided into:

MBpli **Inboard facies**—Bouldery diamict of angular andesite, finely lobate and leveed. Consists of angular gray to reddish andesite clasts as large as 3.3 m but mostly smaller than 1 m. Capped by pinkish incipient soil, and the soil discontinuously topped by rare pumiceous B tephra and by Katmai 1912 silt ash. Below altitude 180 m, heavily vegetated; above altitude 180 m, only sparsely so but more than 1976 and 1964 deposits

MBplo **Outboard facies**—Cobbly sand diamict as thick as 4.1 m atop sea cliff (now isolated from the sea) along inner margin of West Lagoon. Overlies soil developed on M? tephra and capped by pumiceous B? tephra. Upslope becomes intricately lobate and leveed and with many meters of local relief. Included are poorly exposed patches in adjacent southeast swale similarly vegetated in brush alder but veneered by tongues of unit 76p too thin and digitate to map at 1:25,000 scale

MBp **Pyroclastic-flow deposit**—Massive pebbly sand at least 1.2 m thick containing lithic clasts as large as 20 cm. Overlain by more than 1 m section of fluvial debris, ash layers, and organic layers capped by B? tephra

MBas **Southeast Beach debris-avalanche deposit**—Bouldery diamict exposed in upper part of bluff along Southeast Beach. Deposit studded with angular blocks as large as 2.5 m in sand and as large as 6 m as lag on beach and as large as 7 m seaward. Matrix is sandy gravel of similar finer-grained material. Overlain by B tephra; underlain by M and C tephras, which overlie unit HCpe that forms most of bluff

MBlp **Lahar or pyroclastic-flow deposit**—Sandy gravel diamict containing angular lithic andesite clasts rarely as large as 2 m on southeast coast. Associated with unit MBas to west. Overlain by B tephra, underlain by M and C tephras. Apparently similar deposit mapped as unit MBplo in southwest swale

MBl **Lahar deposit**—Diamict of granular medium sand capping terrace at mouth of West Kamishak Creek. Contains angular andesite clasts as large as 50 cm but no pumice. Overlies M tephra. Underlies laharic facies of unit 76p at mouth of creek

Deposits between C and M tephras (about 1,000–750 ^{14}C yr B.P.)

CMal **Lagoon debris-avalanche deposit**—Bouldery diamict including blocks as large as 4 m. Matrix is sandy gravel of identical but finer-grained angular material. Whole deposit is hummocky, individual hummocks having relief as high as 30 m and irregular basal diameters as much as 200 m, but typically 3–15 m high with basal diameters 20–80 m. Overlain by B tephra

CMp **Pyroclastic-flow and pyroclastic-surge deposits**—Along northwest margin of West Lagoon, vaguely bedded very fine sand to silt ash at least 30 cm thick (base not exposed); overlain by M(?) tephra. Also west of West Kamishak Creek at coast, small-volume nonoxidized massive gravelly sand (pyroclastic-flow deposit) overlying oxidized unit HCpw and sandwiched between tephra layers C and M

CMl **Lithic pyroclastic-flow (or lahar) deposits**—Cobble gravel to poorly sorted gravelly sand; angular to subangular lithic clasts as large as 25 cm; includes pumice. Underlain by tephra layer C; overlain locally by an ill-defined tephra layer O and by tephra M

Deposits between H and C tephras (about 1,400–1,100 ^{14}C yr B.P.)

IMan **North Bench debris-avalanche deposit**—Bouldery diamict including blocks as large as 3.5 m. Matrix is sandy gravel of identical but finer-grained angular material. Deposit is only moderately hummocky with local relief as high as 6 m. Cut into gently curving sea cliff as high as 35 m (since half buried), whose development was arrested by emplacement of Grouse Point deposit. This deposit with its high seacliff is geomorphically similar to several coarse deposits on east and south coast and must be older than indicated by local stratigraphy. Sparsely overlain by B or M tephra. May predate C tephra

Southeast lithic pyroclastic-flow (and lahar?) deposit—Divided into:

HClp **Proximal facies**—Contains numerous angular surface boulders 4–6 m, a few as large as 9 m. Surface texture coarsely lobate and leveed with local relief as high as 2.5 m. Some smaller blocks prismatically jointed. Directly overlain by C tephra

HClc **Coastal facies**—Cobble gravel to sandy cobble gravel containing subangular rather than very angular clasts, vaguely stratified and lacking in large boulders, suggestive of lahar deposit. Surface laced with many close-spaced levees. Directly overlain by C tephra and directly underlain by H tephra

HCpe **Southeast pyroclastic fan**—Massive pumiceous gravelly medium sand (pyroclastic-flow deposit) with interbedded gravelly zones as thick as 31 m. Overlain by C and M tephras

Southwest pyroclastic fan—Divided into:

HCpwp **Pumiceous pyroclastic-flow deposit**—Massive pumiceous gravelly medium sand (pyroclastic-flow deposit) as thick as 5 m. About 80 percent of gravel clasts are pumice as large as 10 cm, the rest are angular lithic andesite as large as 5 cm. Upper 2 m oxidized reddish. Overlain by C and M tephras; underlain by massive sandy gravel more than 5 m thick, unit HClu. Surfaces inland are smooth and free of boulders

HCpwl **Lithic pyroclastic-flow deposit**—Cobble to boulder gravel containing angular to subangular clasts of variously gray to reddish porphyritic andesite. Upslope, boulders commonly as large as 3 m, rarely as large as 9.5 m; in coastal exposures boulders smaller than 0.5 m. Surface of upslope portion embellished by numerous intricately lobate margins downslope from close-spaced levees. Upslope portion overlain erratically by tephra C and extensively by tephra M. Coastal portion overlain by pumiceous pyroclastic-flow deposit (unit HCpwp) capped by these tephras

HCl **Lahar**—Massive sandy gravel more than 5 m thick, probably laharic

HCas **South Point debris-avalanche deposit**—Bouldery diamict of angular porphyritic-andesite fragments. Similar to units Bar, MBag, and MBal, including surface boulders commonly as large as 2 m, many in 4–5 m range, rarely as large as 9 m. Hummocky surface with as much as 10 m of local relief but much subdued by overlying tephra and peat deposits. Overlain only by section containing C and M tephras. Cut back into sea cliff as high as 30 m that projects 600 m seaward as a broad, sharp salient

HCal **Long Beach debris-avalanche deposit**—Bouldery diamict of angular fragments dominantly of porphyritic andesite but also containing smaller sandstone clasts. Hummocks as tall as 9 m, andesite boulders rarely as large as 6–9 m. Poorly exposed

Deposits between I and H tephras (about 1,700–1,400 ^{14}C yr B.P.)

IHa **Northeast Point debris-avalanche deposit**—Bouldery diamict about 3.2 km broad, of angular porphyritic-andesite fragments. Similar to units MBag, MBal, and HCas, including 2- to 4-m surface boulders, rarely as large as 7 m. In places pods 30 m long and 10 m high consist of nearly monolithologic andesite as close-packed very angular clasts. Hummocky surface with as much as 9 m of local relief but both relief and slopes much subdued by thick overlying tephra and peat deposits. Overlain by H and younger tephras, underlain by I tephra. Cut back into sea cliff as high as 18 m that projects seaward 400 m as a narrowed salient. Buries an older sea cliff

IHla **Lahar and debris-avalanche deposit**—Deposit as thick as 20 m atop landslide block 2.2 km west of South Point. Massive diamicts with angular andesite boulders as large as 4 m (debris-avalanche deposit?) overlie and underlie similar deposits but with smaller and fewer boulders and with vague bedding (apparently lahar deposit). May be arms of units HCl and of unit HCas or HCal. May underlie H tephra as well as C tephra

IHl **Lahar(?) deposit**—Sandy gravel diamict containing angular porphyritic andesite outside (north) of levee delineating north side of main part of Northeast Point diamict (unit IHa). Similar sandy gravel lies south of margin of Northeast Point debris-avalanche deposit and also beneath tephra H? atop the big landslide block on south side of island

Deposits between G and I tephras (about 2,100–1,800 ^{14}C yr B.P.)

Glays **Yellow Cliffs and Southeast Point debris-avalanche deposits, composite**—Bouldery diamict of angular porphyritic-andesite fragments. Comprises two stratigraphically superposed similar deposits, the diamict overlain by Southeast Point diamict. Where not buried by unit IHa, the hummocky surface of Southeast Point deposit has 5 to 8 m of local relief albeit much subdued by thick capping tephra and peat deposits (thickest in interhummock lows). Southeast Point deposit overlain by I and younger tephras. Unlike all other Augustine debris-avalanche deposits, the Yellow Cliffs unit consists largely of andesite clasts that are yellowish and highly altered to clay; its local surface relief seen in sea-cliff section is at least 5 m

Deposits older than G tephra (about 2,500–2,100 ^{14}C yr B.P.)

Ga **East Point debris-avalanche deposit**—Bouldery diamict of angular porphyritic-andesite fragments, a few prismatically jointed (juvenile). Underlies Yellow Cliffs diamict (lower diamict of unit Glysa) and underlies sparsely exposed G tephra. Similar to unit IHa, including angular boulders as large as 4–8 m

Domes and lava flows of uncertain late(?) Holocene age

ds **Pre-1883 summit-dome complex**—Succession of porphyritic-andesite domes forming east crater rim and steep upper east and south outer flanks. Apparently little changed since 1883 eruption. Divided by surface color and apparent overlapping relations into three parts (oldest, 1; youngest, 3)

Flank features—Divided into:

dp **Dome P**—Topographic bump on the northwest volcano flank at altitude 910 m consisting of gray (N 5/0) porphyritic andesite containing about 15 percent plagioclase phenocrysts as long as 4 mm

df **Dome F**—Topographic bump on the northwest volcano flank at altitude 1,025 m consisting of pinkish gray (7.5R 6/2) porphyritic andesite containing about 15 percent plagioclase phenocrysts as long as 4 mm

dk **Dome Kamishak**—Topographic bump on the south volcano flank at altitude 513 m consisting of light gray (N 7/1 to 5YR 6/1) porphyritic andesite containing about 15 percent plagioclase phenocrysts and about 3 percent hornblende phenocrysts, both as long as 3 mm

ld **Lava flow**—Inliers on south flank of in-situ porphyritic andesite with steep seaward slope: old dome and (or) lava flow nearly buried by younger materials

DEPOSITS OF LATE PLEISTOCENE (TO HOLOCENE ?) AGE

PHfp **Fall deposits and pyroclastic-flow deposits, undivided**—Interbedded pumiceous pyroclastic-flow deposit, lithic pyroclastic-flow deposit and many beds of loose, sorted pumiceous fall deposits exposed on sides of several south-flank kipukas. Uppermost beds probably correlative with M, C, and older tephra beds of coastal sequences. In places, lowest parts of these sequences overlain by Pleistocene glacial deposits

DEPOSITS OF LATE(?) PLEISTOCENE AGE

Pg **Glacial deposits**—Sandy gravel or gravel veneer of diverse angular clasts as large as 1.5 m of exotic lithology including black argillite, diorite, granodiorite, granite, gneiss, porphyritic dike rocks, gabbro, greenstone, and banded limestone and chert. Probably discontinuous till; found only on south side of island

Po **Outwash gravel**—Water-laid pumiceous and lithic pebble to granule gravel locally rich in exotic, rounded pebbles. Found only on south side of island. Section contains bed of angular pumice, apparently tephra-fall deposit

Volcanic materials—Divided into:

Pvr **Rhyolitic pumiceous beds**—Thickly bedded gravelly sand diamict containing angular to rounded pumice clasts (pyroclastic-flow beds), alternating with beds of sorted angular pebble gravel of angular pumice clasts (fall beds). Fall beds contain as much as 40 percent lithic clasts

Pvb **Basaltic hyaloclastite**—Poorly bedded sandy pebble gravel containing angular clasts as large as 10 cm, rarely to 20 cm, of scoriaceous olivine basalt. Locally overlain by bedded rhyolitic pumice (unit Pvr). Base exposed in one site shows 3 m of fragmental flow deposits containing lithic andesite and pumice clasts (included in this map unit)

Pl **Block landslide**—Sandstone and shale of Naknek Formation highly jointed and faulted, riddled with open fissures, apparently a displaced block derived upslope from unit Jnsu

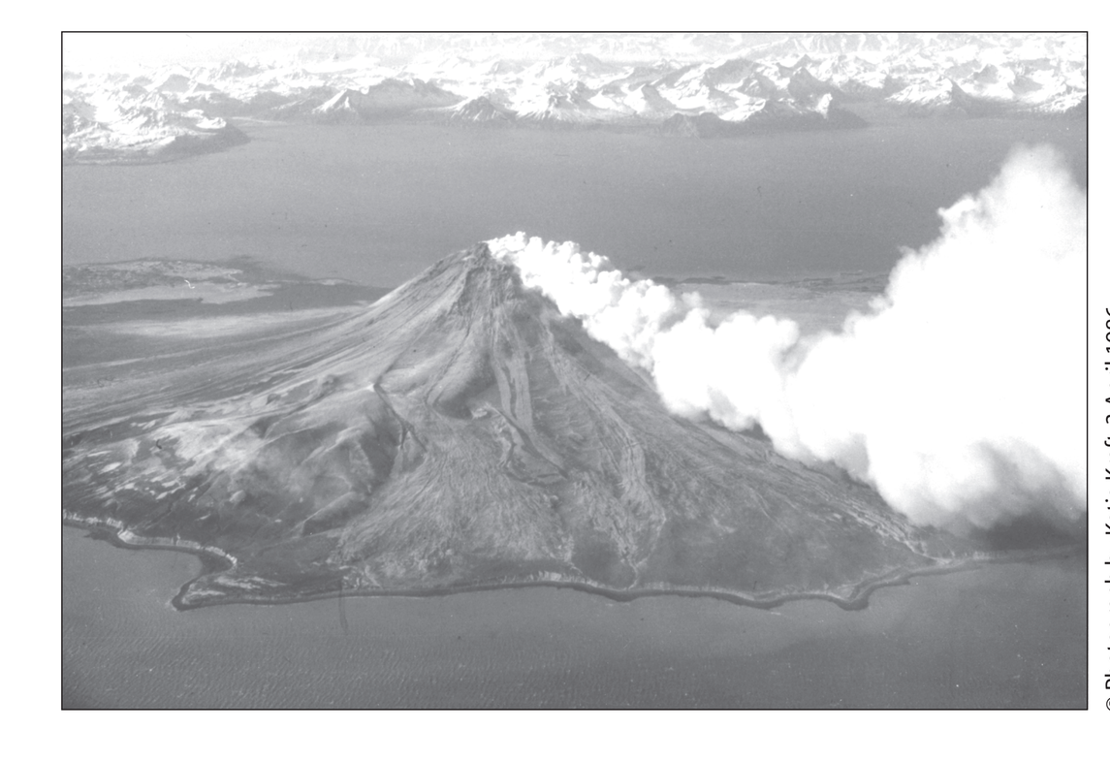
ROCKS PREDATING AUGUSTINE VOLCANO

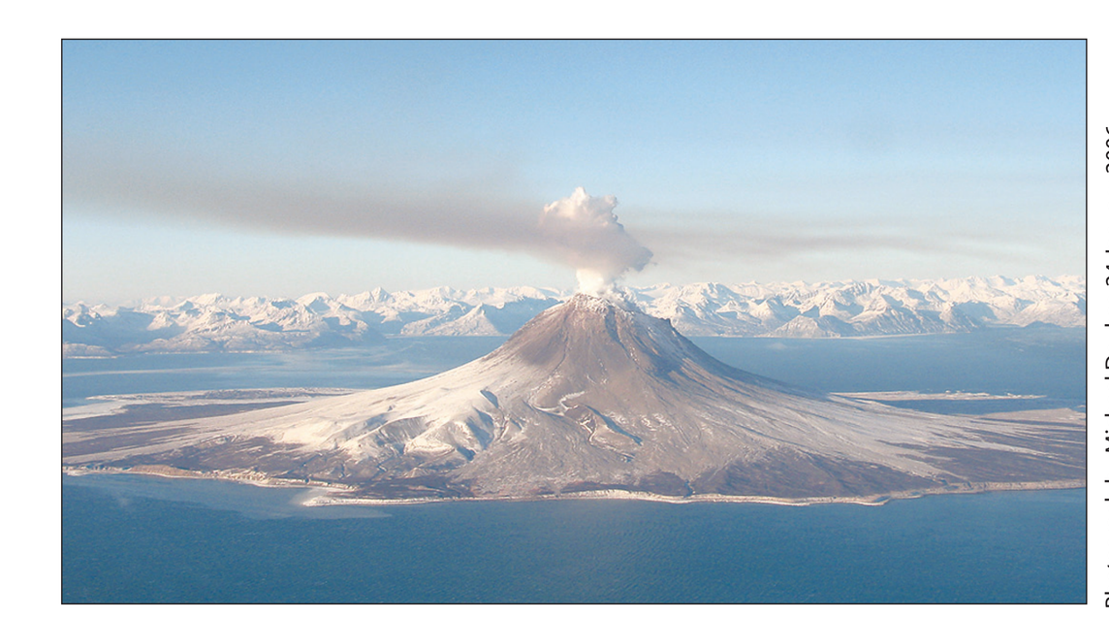
Kk **Kaguyak Formation (Upper Cretaceous)**—Poorly exposed, oxidized, weathered, greenish sandstone and sandy pebble conglomerate sparsely containing *Inoceramus* and other upper Cretaceous fossils (Detterman and Jones, 1974). Since 1976 Augustine eruption, exposed only in gullly at head of West Kamishak Creek at altitude 350–400 m

Naknek Formation (Upper Jurassic)—Shown only on cross section. Divided into:

Jns **Upper sandstone**—Cliff-forming medium to fine thick-bedded, yellowish, pale-brown sandstone with partings of very fine sandstone to siltstone. Locally ripple marked and containing foreset beds as thick as 1.5 m dipping west or southwest. Rich in marine shells and rare flattened logs and stems. Upsection becomes rich in granule to pebble conglomerate containing rounded stones of mixed crystalline rock types

Jnsh **Shale**—Dark-gray shale, mostly siltstone with thin interbeds of sandstone. Includes at base lower sandstone of Buffler (1976); crops out mostly below high-tide line





GEOLOGIC MAP OF AUGUSTINE ISLAND, ALASKA

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