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GEOLOGIC MAP OF THE BIG DELTA B-2 QUADRANGLE, EAST-CENTRAL ALASKA

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SCALE 1:63 360
CONTOUR INTERVAL 100 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Base modified from U.S. Geological Survey, 1958;
minor revisions 1975.
Transverse Mercator projection.
1927 North American Datum.
10,000-foot grid based on Alaska coordinate
system, zone 3.
1,000-meter Universal Transverse Mercator
grid ticks, zone 6.

See "Index to geologic mapping."
Editing and digital cartography by
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DESCRIPTION OF MAP UNITS

QUATERNARY SURFICIAL DEPOSITS

Qac Alluvial and colluvial deposits (Quaternary)—Boulder- to silt-size, unconsolidated alluvial and colluvial deposits. Unit includes material deposited in stream channels, flood plains, abandoned river and stream channels, swamps, and wetlands

Qc Colluvial deposits (Quaternary)—Boulder- to cobble-size, unconsolidated talus, slope-failure deposits, colluvium, and minor alluvial deposits. Unit includes alluvial deposits within small, narrow active stream channels

TERTIARY IGNEOUS ROCKS

Tb Basalt (Tertiary)—Dark-gray to black, nonfoliated basalt dike containing small, randomly oriented plagioclase phenocrysts set in devitrified aphanitic groundmass. Age uncertain, but may be correlative with a 50 Ma basaltic dike swarm occurring throughout Yukon-Tanana Upland. Crops out poorly in sec. 15, R. 15 E., T. 6 S. in upper part of Sonora Creek drainage

CRETACEOUS IGNEOUS ROCKS

Kdt Diorite and tonalite (Late Cretaceous)—Medium-grained, dark-gray, nonfoliated, equigranular, hornblende-biotite diorite to tonalite. In Liese Creek, outcrops of unit exhibit weak to moderate quartz-chlorite-sericite alteration and overlie the Pogo gold deposit. Smith and others (1999) reported a ≈94.5 Ma U-Pb zircon age for the diorite of Liese Creek. Sericitic alteration of the diorite of Liese Creek ranges in age from 91.2 to 91.7 Ma using 40Ar/39Ar technique (Smith and others, 1999) and postdates the main gold mineralization event at the Pogo gold deposit at 104.3±0.3 Ma (Selby and others, 2002)

Kgsp Shawnee Peak intrusion (Late Cretaceous)—Coarse-grained, nonfoliated, equigranular, light-gray, biotite diorite to biotite tonalite; forms western flank of Shawnee Peak. Lacks evidence for intergranular recrystallization as seen in the granite of Swede Peak (unit Kgs), implying intrusion occurred at a higher structural level relative to the granite of Swede Peak and emplacement postdated regional Early Cretaceous deformation

Kgs Granite of Swede Peak (Early? Cretaceous)—Coarse-grained, light-gray to white, biotite-garnet-muscovite leucogranite. In thin section, quartz and feldspar crystals exhibit mortar texture, and quartz shows undulatory extinction indicating post-emplacement strain and interstitial recrystallization possibly due to relatively deeper level of initial emplacement or emplacement during later stages of Early Cretaceous (≈116 Ma) regional tectonism. Western margin of unit is intrusive into overlying unit Pzpg. Contact with thrust fault on northeast margin of intrusion is buried beneath valley-fill alluvium; southwest-trending thrust fault does not appear to cut the intrusion. Eastern margin of unit cut by high-angle fault

Kg Granite stock (Early? Cretaceous)—Small, medium- to coarse-grained, nonfoliated to weakly foliated stocks and plugs of leucocratic biotitic granodiorite to granite composition; locally contains muscovite. Mortar texture between quartz and feldspar phenocrysts, combined with weak foliation in mesoscopic scale, indicates unit was at least partially recrystallized. Age uncertain, but predominantly nonfoliated texture indicates unit emplaced after Early Cretaceous regional tectonism

Kgb Goodpaster batholith (Early Cretaceous)—Composite batholith made up of nonfoliated to weakly foliated, coarse-grained, equigranular biotite granodiorite, granite, and pegmatite. Southern part of batholith is a border phase of medium-grained, hypidiomorphic, equigranular, moderately foliated biotite granodiorite; distinguished from adjacent biotite-sillimanite gneiss (unit Pzgn), which unit Kgb intrudes, by lack of recrystallization and lesser amounts of intense sericitic alteration. Foliated southern margin of batholith probably represents an earlier (late-kinematic) phase of plutonism, whereas the weakly foliated to nonfoliated central part of batholith along the Goodpaster River probably represents a later (post-kinematic) phase of plutonism. Dilworth and others (2002) reported a U-Pb zircon age range of 107–109 Ma for late-kinematic plutonism and as young as ≈104 Ma for post-kinematic plutonism of rocks included in the Goodpaster batholith. Unit forms relatively low, rounded hills along center of Goodpaster River basin; crops out poorly

Kgcd Granitoid dike (Early Cretaceous)—Composite granitoid dikes; highly variable compositions include light-gray, fine-grained, equigranular, nonfoliated biotite granodiorite, coarse-grained leucogranite, and simple biotite quartz alkali-feldspar pegmatite. Late-stage quartz veins cut earlier dike rock. Plagioclase phenocrysts exhibit characteristic strong compositional zonation. Potassium- and silicia-rich gossans commonly developed in adjacent country rock. Zones of anomalous gold and sulfide mineral (pyrite, arsenopyrite, stibnite) concentrations occur in both quartz veins and pegmatitic zones in country rock near dike margins. U-Pb sensitive high-resolution ion microprobe–reverse geometry (SHRIMP RG or SHRIMP) dating of zircon overgrowths on Paleozoic xenocrystic cores indicates a crystallization age of 106±3 Ma; U-Pb SHRIMP dating of monazite yields an age of 113±5 Ma (sample 01AD-257; table 1). The 113±5 Ma U-Pb SHRIMP age represents a maximum crystallization age for the dike inasmuch as the sample may contain excess 206Pb, which would yield an older apparent crystallization age. Lack of penetrative tectonic fabric indicates unit is post-kinematic, emplaced after Early Cretaceous regional tectonism, which is recorded in metamorphic zircon overgrowths in units Pzgn and Pzg

Kgru Granodiorite to granite, undivided (Early Cretaceous)—Medium- to coarse-grained, equigranular biotite granodiorite to granite. Composed of as much as 5 percent biotite; locally contains accessory amounts of garnet, ilmenite, chlorite, and apatite. Biotite is altered to muscovite. Smith and others (1999) reported U-Pb monazite ages of 107.1–107.9 Ma

PALEOZOIC AND OLDER METAMORPHIC UNITS

Dag Augen gneiss (Late Devonian)—Inhomogeneous orthogneiss dominated by light-gray, medium- to coarse-grained, strongly foliated biotite-muscovite±sillimanite quartzofeldspathic augen gneiss with zones of relatively augen-free biotite gneiss of granodioritic to granitic bulk composition. Unit is characterized by lenticular-shaped augen made up of alkali feldspar porphyroblasts (as much as 5 cm in diameter) and quartz, feldspar, mica, and garnet mineral aggregates set in a medium-grained, foliated to granoblastic matrix of granodioritic composition. Anastomosing mica-rich shear bands separate zones of both equigranular matrix and augen into sigmoid-shaped zones (mesolithons). Mesolithons commonly have asymmetric tails forming oriented "fish" bounded by micaceous shear bands that display S-C mylonitic fabrics formed during ductile regional metamorphism. Dusel-Bacon and Aleinikoff (1985) described the regional geologic context for the unit and suggested a plutonic protolith.

Dusel-Bacon and others (2001) reported a Late Devonian U-Pb zircon SHRIMP age of 362±3 Ma (their sample AG-2) from an augen gneiss sample taken north of Central Creek and west of California Creek. U-Pb zircon SHRIMP ages of 365±4 Ma (Late Devonian) obtained for contiguous unit approximately 10 km east of map area (sample AG-3; table 1). A sample from the same map unit yielded a 388±3 Ma (Middle Devonian) age as reported by Dusel-Bacon and others (2001) (their sample AG-5; lat

64°18'34" N., long 144°26'30" W.). The Late Devonian age reported here (sample AG-3; table 1) supersedes that reported by Aleinikoff and others (1986), who published a U-Pb concordia age of 341±3 Ma (Early Mississippian) on zircons from several samples of the gneiss. Aleinikoff and others (1981; their sample AG-5) reported K-Ar dates on muscovite of 113±4 Ma and on biotite of 110±4 Ma, reflecting postmetamorphic cooling during the Early Cretaceous

Ddg Dioritic orthogneiss (Late Devonian)—Dark-green, medium-grained, foliated, hornblende-biotite±garnet dioritic orthogneiss. Interpreted to be a cognate mafic phase of the Devonian augen gneiss (unit Dag); contact zone with augen gneiss is apparently not faulted and is a typical igneous contact. Major- and trace-element geochemical data (W. Day, unpub. data, 2002) are compatible with interpretation that unit Ddg is cognate with plutonic protolith of unit Dag. A SHRIMP U-Pb date of 369±6 Ma from zircon core from a dioritic orthogneiss (sample 02AD332; table 1) represents a Devonian age of primary crystallization. No Cretaceous metamorphic overgrowths were noted on the zircons, although unit experienced the same tectonic events recorded in the enclosing augen gneiss (unit Dag). Dusel-Bacon and others (2001) reported an age of 361±3 Ma for an "amphibolite" interlayered in drill core from the same augen gneiss body that they interpreted as a cognate phase within the augen gneiss body (Dusel-Bacon, oral commun., 2002). Wilson and others (1985) reported a K-Ar age of 188±5.6 Ma for hornblende (metamorphic) from unit. Dusel-Bacon and others (2002) reported 40Ar/39Ar ages of 181±7 Ma and 130 Ma on hornblende from the unit, which would represent time of post-peak metamorphic cooling from Mesozoic deformation and metamorphic events. Dusel-Bacon and coworkers' previous studies also interpreted the unit to be a cognate mafic enclave within protolith intrusion of the augen gneiss

Dog Granodioritic orthogneiss (Middle to Late Devonian)—Predominantly light to medium gray, medium-grained, layered trondhjemitic to granodioritic orthogneiss with lesser amounts of biotite schist, quartzite, and paragneiss. Occurs in northern and western parts of map area and is distinguished from unit Pzgn by lack of sillimanite. Xenocrystic zircon cores vary in age from 367 Ma to 1,184 Ma (sample 02AD339; table 1). One zircon core yields a U-Pb SHRIMP age of 367±7 Ma and is rimmed by a 380±12 Ma moderately zoned (igneous) zircon overgrowth. Both Devonian ages are within error of each other and indicate a Middle to Late Devonian emplacement age of the protolith, which is equivalent to slightly older than that of the protolith for the augen gneiss (unit Dag). U-Pb SHRIMP ages on zircon rims show two populations—an older group at 114±2 Ma and a younger group at 109±2 Ma (sample 02AD339; table 1). U-Pb SHRIMP data on zircons from unit indicate that protolith intrusion inherited zircons from a crustal source that was in part Precambrian, was emplaced during the Devonian, and was recrystallized twice during pulses of regional Cretaceous tectonism at ≈114 Ma and at ≈109 Ma

Pzmg Mafic gneiss (Paleozoic)—Dark-green, fine- to medium-grained, strongly foliated, hornblende-biotite amphibolite gneiss interlayered with foliated, medium-grained, equigranular calc-silicate schist. Calc-silicate schist contains hornblende, biotite, and diopside. Basal contact with underlying augen gneiss (unit Dag) is highly sheared biotite phyllonite; contact is a mylonite zone (fig. 1) interpreted to be associated with regional low-angle faulting. Bodies represent structural klippe resting upon the augen gneiss (unit Dag)

Pzum Ultramafic schist (Paleozoic)—Dark-green, foliated, serpentinized ultramafic schist. Weathers to light-brown color; protolith was peridotite. Equivalent to unit Pzu of Weber and others (1978). Age uncertain, but protolith presumed coeval with unit Pzmg. Basal contact poorly exposed, but structural discordance in foliation directions with underlying units suggests contact is low-angle fault

Pzq Quartzite and metapelite (Paleozoic)—Light-gray, equigranular, muscovite-bearing quartzite and metapelite. Protolith was an immature graywacke interlayered with pelite. Age uncertain, but protolith assumed to be part of now structurally disrupted sedimentary sequence that includes the protoliths for units Pzpg, Pzg, and Pzgn

PzpgParagneiss (Paleozoic)—Medium-gray, equigranular, medium- to fine-grained quartzofeldspathic biotite schist with lesser amounts of metapelite and quartzite. Locally, dark-gray, medium-grained biotite schist horizons are interlayered with light-gray, fine- to medium-grained, equigranular quartzofeldspathic biotite schist horizons (1–5 cm thick) as well as light-gray, medium-grained pelitic horizons. Metamorphic mineral assemblage includes biotite, muscovite, garnet, and, locally, sillimanite. Protolith for unit was graywacke to muddy siliciclastic sediment and sandstone. Depositional age of protolith uncertain. Zircon U-Pb age dates by Aleinikoff and others (1986) on a sample from same map unit of Weber and others (1978; unit Pzp₵g) range from Mississippian to Paleoproterozoic; the older ages are from inherited detrital zircons eroded from a Precambrian crustal source. Dusel-Bacon and others (2002) reported 40Ar/39Ar age of 135 Ma on hornblende from ridge crest east of Sonora Creek. The Early Cretaceous age is thought to represent a metamorphic cooling temperature from regional tectonism

Pzg Biotite gneiss (Paleozoic)—Medium-gray, medium-grained, layered, foliated biotite-muscovite±garnet quartzofeldspathic biotite gneiss. Southern part of unit dominated by medium-gray, equigranular, massive biotite-muscovite orthogneiss(?) of similar granodioritic composition as groundmass of augen gneiss (unit Dag). Retrograde chlorite, iron oxide, and sericite occur along late-stage foliations. Larger grain size and absence of biotite-sillimanite intergrowths distinguishes unit from unit Pzgn. Small body mapped as inlier in unit Dag south of Central Creek (sec. 6, R. 16 E., T. 7 S.) contains biotite, muscovite, garnet, and staurolite. The main contact with the Devonian augen gneiss (unit Dag) is faulted in this map area; however, inlier of unit Pzg in unit Dag as well as apophyses of unit Dag within unit Pzg south of Central Creek indicate that unit was country rock to the Mississippian-Devonian plutonic protolith, which is now represented by unit Dag. Equivalent to unit Pzp₵g of Weber and others (1978). U-Pb zircon SHRIMP and cathodoluminescence data show that the zircons are compositionally zoned similar to unit ggn. Inherited zircon cores (sample 01AD-269; table 1) range in age from about 1,020 to 2,585 Ma, indicating source terrane for the sedimentary protolith included Precambrian continental crustal material. Euhedral metamorphic overgrowths are Early Cretaceous (116±4 Ma). Aleinikoff and others (1986) dated inherited zircons from metavolcanic rocks interlayered within the unit south of this map area (unit Pzp₵g of Weber and others, 1978); yet one sample (Aleinikoff and others, 1986; sample 4017; –400 mesh fraction) yielded a Devonian 207Pb/206Pb age of approximately 383 Ma, representing the upper age limit for the deposition of the protolith. The last intense ductile deformation event experienced by the gneiss was Early Cretaceous (≈116 Ma), which presumably was coeval with development of the prominent schistosity as well as the mineral and stretching lineations

Pzgn Biotite-sillimanite gneiss (Paleozoic)—Medium- to dark-gray, medium-grained, foliated, equigranular biotite gneiss of sedimentary origin interlayered with gray trondhjemitic to granodioritic orthogneiss. Paragneiss component is characterized by discontinuous horizons of light-gray, foliated, silicic biotite-muscovite±sillimanite gneiss. Unit is distinguished from unit Pzg by darker color, relatively weaker foliation, presence of sillimanite, and a higher biotite content. Unit is distinguished from unit Dog by presence of sillimanite. Primary large biotite flakes locally recrystallized into intergrowths of fine-grained biotite, white mica, and veinlets of secondary fibrolitic sillimanite. Secondary white mica alteration of plagioclase is characteristic and does not occur in biotite gneiss unit Pzg. Equivalent to unit Pzg of Weber and others (1978). SHRIMP and cathodoluminescence data from a paragneiss horizon (sample 01AD-213; table 1) show that the zircons are compositionally zoned with inherited rounded detrital cores and euhedral metamorphic overgrowths. The zircon core ages range from about 970 to 1,150 Ma. Zircon rims are Early Cretaceous (116±2 Ma) and represent age of regional metamorphism and tectonism. U-Pb dating of monazite yields an age of 112±2 Ma; the monazite presumably grew during a later phase of the regional deformation

GEOLOGIC OVERVIEW

Crystalline rocks of the Yukon-Tanana Upland of east-central Alaska (fig. 2) underlie the Big Delta B-2 quadrangle. Gold exploration has remained active throughout the region in response to the discovery of the Pogo gold deposit, which lies within the quadrangle near the Goodpaster River. Geologic mapping and associated geochronological and geochemical studies by the U.S. Geological Survey (USGS) and the Alaska Department of Natural Resources, Division of Mining and Water Management, provide baseline data to help understand the regional geologic framework.

The oldest geologic units within the map area are an interlayered series of interlayered biotite gneiss, quartzite, and metapelite. Three separate biotite gneiss units were identified: (1) medium- to dark-gray, medium-grained, foliated, equigranular biotite-sillimanite gneiss that crops out south and east of Shawnee Peak (unit Pzgn); (2) medium-gray, medium- to coarse-grained, strongly foliated biotitic quartzofeldspathic gneiss present south of Central Creek in the western part of the quadrangle (unit Pzg); and (3) medium- to fine-grained metagraywacke (unit Pzpg) south of Central Creek in the western part of the quadrangle, which is interlayered with quartzite and metapelite (unit Pzq) north of Central Creek and west of Sonora Creek. These units represent metamorphosed epiclastic to pelitic sediments containing zircons with detrital cores that range in age from about 1,020 to 2,585 Ma.

The augen gneiss (unit Dag) and dioritic orthogneiss (unit Ddg) intruded the quartzofeldspathic biotite gneiss (unit Pzg) and the granodioritic orthogneiss (unit Dog) intruded the biotite-sillimanite gneiss (unit Pzgn) during an early, albeit poorly understood, Middle to Late Devonian plutonic event. The augen gneiss is in fault contact with the biotite-sillimanite gneiss (unit Pzgn) on its northern margin (southeast of Shawnee Peak), the paragneiss (unit Pzpg) on its western margin in the Sonora Creek area, and the mafic gneiss (Pzmg).

The rocks in the Big Delta B-2 quadrangle have experienced several episodes of tectonism that span from the Devonian to the Tertiary. The first episode (D1), described in the preceding paragraph, accompanied the initial emplacement of the protolith intrusion for the augen gneiss (unit Dag), dioritic orthogneiss (unit Ddg), and granodioritic orthogneiss (unit Dog). The felsic plutonism and concomitant mafic magmatism were widespread throughout the Yukon-Tanana Upland (Dusel-Bacon and others, 2001; Hansen and Dusel-Bacon, 1998), and were thought to be the result of regional Paleozoic plutonism along the margin of the North American craton (Dusel-Bacon and Aleinikoff, 1985; Dusel-Bacon and others, 1995). The evidence for penetrative D1 fabric elements, potentially associated with the Paleozoic plutonism, was obliterated during the subsequent intense Mesozoic tectonic and metamorphic events (Dusel-Bacon and Hansen, 1992; Dusel-Bacon and others, 1995; Day and others, 2002). Kinematic and isotopic evidence indicates that the rocks in the Big Delta B-2 quadrangle underwent at least two ductile deformation events (D2 and D3) as part of the regional Mesozoic deformation that affected the Yukon-Tanana tectonic terrane. These two Mesozoic events, during the Jurassic and Cretaceous, respectively, variably affected the bedrock throughout the map area. This areal variation in Mesozoic deformation is revealed by kinematic analysis of the bedrock, which shows that there are two broad structural "domains" containing unique structural fabrics that point to differing tectonic histories (fig. 3).

Structural domain I is underlain by predominantly augen gneiss and biotite gneiss (units Dag and Pzg, respectively) and occurs in the southeastern part of the quadrangle. Structural domain II is made up of biotite gneiss, orthogneiss, paragneiss, and quartzite (units Pzgn, Dog, Pzpg, and Pzq, respectively) and lies in the northern and western part of the quadrangle. These two structural domains are separated by a series of thrust and high-angle faults that extend from the southern flank of Shawnee Peak westward beneath Sonora Creek, along the ridge between Central Creek and the Goodpaster River, and project southward along the north-trending high-angle fault east of the Swede Peak intrusion. We interpret that the rocks of domain II (footwall) were structurally overlain by those of domain I (hanging wall) along the south- and southeast-dipping master thrust fault that originally separated the two domains. Subsequent high-angle, brittle faulting has disrupted the original Mesozoic structural stacking sequence.

The ductile structural fabric elements in domain I (fig. 3) include a strong schistosity, S-C mylonitic fabrics, stretching lineations, and asymmetric alignment of sigmoidal lithons and augen. Biotite, muscovite, and the flattened feldspar augen define the schistose fabric (S2), which is commonly cut by later micaceous shear bands (S3), forming D3 S-C mylonitic fabrics. The D3 ductile deformation has produced sigmoidal lithons, made of up earlier schistosity cut by shear bands, as well as developed recrystallized "tails" on the original feldspar augen that also have sigmoidal shapes whose asymmetry is similar to that of the lithons. The D3 fabrics consistently indicate a west-northwest sense of tectonic transport. The regional structural grain defined by the planar elements (schistosity and S-C mylonitic fabrics) wraps around from a westerly strike in the eastern part of the domain to a northerly strike in the southwestern part of the domain, forming a southeast-plunging synform. The axis of the regional synform is coaxial with the predominant southeast plunge of the stretching lineations. The earlier D2 fabrics in domain I were overprinted and reoriented during the later intense tectonic D3 deformation, which thrust rocks of domain I west-northwesterly over rocks of domain II (fig. 3).

The ductile structural fabric elements in the gneissic rocks of domain II (fig. 3) include an S2 schistosity parallel to the original compositional layering (S0), isoclinal F2 folding of the original compositional layering (S0), as well as L2 mineral and intersection (S0 and S2) lineations. The S2 schistosity, as well as the general trend of the unit contacts, imparts a west-northwest-trending structural grain to the area. The subsequent D3 ductile deformation refolded the compositional layering and S2 schistosity into tight to isoclinal F3 folds that plunge shallowly to the west and are accompanied locally by an axial planar S3 schistosity. The strong stretching lineations common in domain I are only present locally in domain II along the original footwall zone of the controlling thrust fault that separates the two domains (for example, west of Sonora Creek).

The absolute age of the Mesozoic ductile deformational events is difficult to ascertain. The age of the D2 event is thought to be preserved in the Jurassic ≈188 Ma K-Ar (Wilson and others, 1985) and 181±7 Ma and 188±6 Ma 40Ar/39Ar ages recorded in metamorphic hornblende (Dusel-Bacon and others, 2002) in dioritic orthogneiss (unit Ddg) located in domain I of this study. These ages represent cooling ages inasmuch as they record the blocking temperature of hornblende (≈500°C) thought to have formed during the D2 deformation. Outside of the dioritic orthogneiss, however, Cretaceous 40Ar/39Ar and K-Ar metamorphic cooling ages predominate (Dusel-Bacon and others, 2002; Wilson and others, 1985) in both domains I and II; no Jurassic metamorphic ages have been observed in the gneissic rocks of domain II. Cretaceous cooling ages associated with the D3 deformation are reflected in the K-Ar ages for metamorphic micas developed in the augen gneiss (Aleinikoff and others, 1981) of domain I, as well as the ≈116 Ma Early Cretaceous zircon metamorphic overgrowths (this study) from the biotite gneiss (unit Pzg) and biotite-sillimanite gneiss (unit Pzgn). The Cretaceous ages record when the micas cooled through their blocking temperatures and do not necessarily reflect the age of peak D3 dynamic recrystallization.

Brittle faulting and emplacement of dikes, stocks, and plutons followed the ductile deformation events during an episode (D4) of regional extension and magmatism. In the northeastern part of the quadrangle, a Cretaceous composite dike swarm (unit Kgcd) cuts the ductile fabrics in the gneiss. These dikes locally host quartz veins rich in gold and antimony mineralization. The composite dikes intruded along high-angle brittle fault zones and themselves are cut by later brittle deformation, indicating that they were emplaced after the regional ductile D3 deformation ceased, but before cessation of the northwest-trending faulting. Zircon from the late-stage dikes (unit Kgcd) yields a crystallization age of 106±3 Ma. A 113±5 Ma U-Pb SHRIMP age on monazite (sample 01AD-257; table 1) represents a maximum crystallization age for the dike; the sample may contain excess 206Pb, the effect of which would be to yield an apparent old crystallization age. These data indicate that the regional ductile deformation ceased at about 116 Ma and that the region was uplifted and cooled, and then underwent brittle extensional deformation at about 106 Ma.

Gold mineralization, such as that of the Pogo deposit, is locally spatially and temporally associated with various phases of the Cretaceous plutonic rocks. Recently, Selby and others (2002) reported a Re-Os date of molybdenite of 104.3±0.3 Ma collected from the L1 vein at the Pogo deposit, which they consider the age of gold mineralization. Selby and others (2002) also reported an 40Ar/39Ar age from the dolomite-sericite alteration zone in the L1 vein at 91.7±0.4 Ma and an 40Ar/39Ar age of 92.7±0.3 Ma from a post-mineralization diabase dike that cuts the L1 vein. Dilworth and others (2002) suggested that the Goodpaster batholith was part of an early granitic suite that crystallized at about

107–109 Ma. Dilworth and others (2002) pointed out that the ≈104 Ma age for the Liese zone mineralization at the Pogo deposit coincides with the 104 Ma age of post-kinematic granites in unit Kgru and suggested at least a temporal relationship between granite emplacement and gold mineralization at the Pogo gold deposit. As well, the 104.3±0.3 Ma age for mineralization at the Pogo gold deposit (Selby and others, 2002) is within the error for the age (106±3 Ma) we measured on a granitoid dike unit (Kgcd) that crops out in the eastern part of the map area. At least one low-angle mylonite zone cuts the gold-bearing quartz veins in the Pogo gold deposit (fig. 4).

During and after plutonism and local deformation, brittle deformation produced northeast- and northwest-trending, high-angle conjugate faults. Tertiary (≈50? Ma) basalt dikes represent the last known igneous activity in the region.

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Contact—Approximately located. Dashed where inferred
Fault—Approximately located. Dashed where inferred; dotted where concealed. Opposed arrows show relative movement where known
Thrust fault—Approximately located. Dashed where inferred; dotted where concealed. Sawteeth on upper plate
Strike and dip of foliation
Inclined
Vertical
Lineation—May be combined with foliation symbol

F2 folds
F3 folds
U-Pb SHRIMP age sample locality—See table 1

INDEX TO GEOLOGIC MAPPING

1 P. Roberts, M. Smith, and other Teck Cominco geologists, 1998–2000.

2 W.C. Day, B.M. Gamble, M.W. Henning, and L.P. Gough, July 1999, July 2000, June 2002.

Figure 1. Mylonitic base of mafic gneiss klippe south of Shawnee Peak.

Figure 2. Tectonic assemblage of the Yukon-Tanana tectonostratigraphic terrane of east-central Alaska showing approximate outline of map area.
Modified from Hansen and Dusel-Bacon (1998).

Figure 3. Generalized structural element map showing the traces of the thrust and normal faults and the locations of folds and schistosity in the Big Delta B-2 quadrangle, Alaska.

Figure 4. Mylonitic zone in quartz vein (Liese vein 1.5) within ore zone of Pogo gold deposit.

Table 1. New U-Pb SHRIMP ages for samples from the Big Delta B-2 quadrangle, east-central Alaska

Map No.	Sample No.	Latitude	Longitude	Map unit	Mineral	Core/rim	Age (Ma)	Rock type
1	02AD332	64.2985°	-144.6477°	Ddg	Zircon	Core	369±6	Dioritic orthogneiss
*	AG-3	64.3492°	-144.3317°	Dag	Zircon	Core	365±4	Augen gneiss
2	01AD-269	64.3640°	-144.8929°	gg	Zircon	Core	≈2,585–1,020	Biotite gneiss
2	01AD-269	64.3640°	-144.8929°	gg	Zircon	Rim	116±4	Biotite gneiss
3	01AD-213	64.4272°	-144.5701°	ggn	Zircon	Core	≈1,150–970	Biotite-sillimanite gneiss
3	01AD-213	64.4272°	-144.5701°	ggn	Zircon	Rim	116±2	Biotite-sillimanite gneiss
3	01AD-213	64.4272°	-144.5701°	ggn	Monazite	Core	112±2	Biotite-sillimanite gneiss
4	02AD339	64.4352°	-144.6534°	Dog	Zircon	Core	1,184–367	Granodioritic orthogneiss
4	02AD339	64.4352°	-144.6534°	Dog	Zircon	Rim (2 populations).	114±2; 109±2	Granodioritic orthogneiss
5	01AD-257	64.4170°	-144.5355°	Kgcd	Zircon	Core	≈445–315	Granodiorite dike

5	01AD-257 Granodiorite dike	64.4170°	-144.5355°	Kgcd	Monazite	Core	113±5
5	01AD-257 Granodiorite dike	64.4170°	-144.5355°	Kgcd	Zircon Rim	106±3	

*Sample No. AG-3 lies within the adjacent Big Delta B-1 quadrangle to the east.
Note: All isotopic analyses were done using the USGS/Stanford sensitive high-resolution ion microprobe–reverse geometry (SHRIMP RG) at Stanford University. The primary oxygen-ion beam operated at about 8 nA and excavated a pit about 25 µm in diameter and 1 µm deep. The magnet was cycled through the mass stations six times per analysis. Elemental fractionation was corrected by analyzing a zircon every fourth analysis of known age standard R33 (419 Ma from monzodiorite, Braintree Complex, Vermont; R. Mundil, Berkeley Geochronology Center, oral commun., 1999; S.L. Kamo, Jack Satterly Geochronology Laboratory, Royal Ontario Museum, oral commun., 2001). The age of each sample was determined by calculating the weighted average of 206Pb/238U ages, which accounts for the analytical errors. Raw data were reduced and plotted by using the Squid and Isoplot/Ex programs of Ludwig (1999, 2001); age errors were calculated at the 95 percent confidence limit.

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