PROFESSIONAL REPORT 106 ALASKA DIVISION OF GEOLOGICAL Robinson and others 1990, sheet 1 of 2 AND GEOPHYSICAL SURVEYS PR106-SH1 Fairbanks Schist unit REGIONAL GEOLOGY AND TECTONIC HISTORY GRAPHITIC SCHIST - Dark-gray to black, fine-grained, thinly The Fairbanks Schist unit is the predominant rock assemblage exposed Gold production from lode deposits in the Fairbanks district has been GRANODIORITE - Gray to dark-gray, fine- to medium-grained The Yukon-Tanana Metamorphic Complex aminated graphite-quartz schist. Unit is locally manganiferous. in the Fairbanks mining district. It is at least 1,200 m thick and composed of quigranular to porphyritic granodiorite. Dominant rock type in estimated at 225,000 to 300,000 troy ounces (Chapman and Foster, 1969; Includes light-gray, thinly laminated, pyritic, quartzite. Protolith metasedimentary and minor metavolcanic rocks that have been Koschmann and Bergendahl, 1968). The principal epigenetic lode deposits the Pedro Dome pluton. Granodiorite composed of plagioclase The Fairbanks area is located in the northwestern part of the Yukonfor this unit may have been a chert. (45 percent), quartz (22 percent), biotite (13 percent), metamorphosed to greenschist-facies grade. Schist and quartzite of the consist of gold-sulfide-quartz and gold-quartz veins and breccias hosted in MAP SYMBOLS Tanana Upland, an area underlain by crystalline rocks of the Yukon-Tanana REFERENCES faults, fractures, shear zones, and stockworks developed in the Cleary hornblende (11 percent), and potassium feldspar (7 percent). metasedimentary lithologies in the unit include muscovite-quartz schist, metamorphic complex. The oldest rocks in the complex are crystalline IMPURE MARBLE - Green, red, brown and buff, medium- to micaceous quartzite, biotite-muscovite-quartz schist, and massive brown and sequence and within intrusive complexes. The epigenetic deposits that are Accessory muscovite, sphene, apatite, zircon, and rutile also schists and gneiss domes that were part of what was formerly known as the Contact - approximately located. gray quartzite. Garnet, feldspar and retrograde chlorite are locally coarse-grained marble that contains variable amounts of garnet, hosted within the metamorphic sequences are usually podiform and Aleinikoff, J.N., and Nokleberg, W.J., 1989, Age of deposition and present (2 percent). Birch Creek Schist Formation (Mertie, 1937). The metamorphic rocks range quartz, chlorite, and dolomite. Where the marble is in contact abundant. Tourmaline, apatite, and zircon are common accessory minerals. provenance of the Fairbanks Schist unit, Yukon-Tanana terrane, eastdiscontinuous and contain highly variable precious-metal values. Vein from greenschist and epidote-amphibolite facies to garnet-amphibolite Thrust fault - saw teeth on upper plate. with the Pedro Dome and Gilmore Dome intrusive bodies, it Mineral assemblages are indicative of greenschist-facies metamorphism. systems are best developed in areas with an appreciable quartzite central Alaska: U.S. Geological Survey Bulletin 1903, p. 75-83. facies. Although micaceous quartzite and pelitic schist are the most common contains a contact metamormorphic mineral assemblage dotted where concealed Aleinikoff, J.N., Dusel-Bacon, Cynthia, and Foster, H.L., 1981, Pelitic rocks within Fairbanks Schist unit are distinguished by the component. Shears developed within the quartzite have well-defined walls, rock types, the metamorphic complex also contains large gneiss dome including idocrase, diopside, hornblende, and scheelite. Geochronologic Studies in the Yukon-Tanana Upland, east-central have open spaces, and are laterally continuous, whereas those developed Basaltic rocks crop out at several localities in the Fairbanks mining presence of gray or brown muscovite and quartz. complexes (Foster and others, 1977; and Dusel-Bacon and others, 1979) and district including Fourth of July Hill and Captains Bluff in the northern part Alaska, in Johnson, N.R.D., and Hudson, Travis, eds., The United within areas dominated by schistose rocks tend to be poorly developed, with Strike and dip of schistosity. subordinate amphibolite, marble, pelitic schist, calc-magnesian schist, and MARBLE - Dark-gray, green to buff, fine-grained, thinly MUSCOVITE-QUARTZ-SCHIST AND MICACEOUS diffuse walls and are generally restricted laterally. of the district and at Birch Hill, Sage Hill, Lakloey Hill, and Brown's Hill in States Geological Survey in Alaska: Accomplishments during 1979: U.S. aminated to thinly bedded siliceous marble. Marble unit contains QUARTZITE - Light-brown to gray, fine- to medium-grained Geological Survey Circular 823-a, p. B34-B37. the south. The basalts are chemically transitional between tholeiites and The economic vein systems in the Fairbanks district developed from at Strike and plunge of lineation. c = crenulation, f = small fold axis, m = mineral grain elongation Intrusive rocks range from quartz diorite to granite intrude the Yukon thin laminations of sulfide mineralization parallel to bedding and least four episodes of volatile transport within a retrograded upper-Bacon, Charles, Foster, H.L., and Smith, James G., 1990 (in press) Rhyolitic alkali basalts (Furst, 1968), and the basalts exposed on Birch and Sage Hills schist composed of light-gray to brown-gray muscovite, gray Tanana Upland at many localities. Some of these masses, including the may be a calcareous exhalite horizon near the top of the Cleary include pillow lavas and palagonite breccias (Forbes and Weber, 1982), both quartz ± biotite, and garnet. Light-brown to buff and gray, finecalderas of the Yukon-Tanana terrane, east-central Alaska: volcanic greenschist metasedimentary-volcanic assemblage (Metz and Hamil, 1986). Charley River and Mt. Harper plutons, are of batholithic dimensions and of which indicate subaqueous emplacement. At several localities, the basalt grained, massively bedded quartzite. remnants of a mid-Cretaceous magmatic arc: manuscript submitted to encompass several hundred square kilometers. Small syenite bodies crop flow units contain silcified Metasequoia remains, which suggest an early or Trace of anticlinal fold axis the Journal of Geophysical Research, 31 p. 1) Early barren, coarse-grained quartz lenses formed within ductile out in the Mt. Prindle and Mt. Harper areas. Mafic and ultramafic PzPcu CLEARY SEQUENCE UNDIFFERENTIATED. shear zones in transition to brittle deformation. An increase in middle Tertiary age (Pèwè and others, 1976). Blum, J.D., 1983, Petrology, geochemistry, and isotope geochronology of the complexes, including diorite, gabbro, hornblendite, and peridotite, occur Trace of synclinal fold axis Gilmore Dome and Pedro Dome plutons, Fairbanks mining district, the abundance and thickness of concordant metamorphic locally throughout the Yukon-Tanana terrane and are generally considered segregation quartz lenses toward the vein zones in the hanging BASALT - Dark-green to black, very fine grained altered basalt. Interlensed near the middle of the Fairbanks schist unit is the Cleary Alaska: Alaska Division of Geological and Geophysical Surveys Report to be alpine ultramafics that are tectonic slices. Location of known mineral occurrence. Mineral deposit data modified from Chapman and Foster (1969). sequence, a unit composed of a bimodal metavolcanic and volcaniclastic Contains phenocrysts of plagioclase and accessory pyroxene. of Investigations 83-2, 59 p. and footwalls of most productive vein systems suggests a U-Pb-zircon dating of metamorphic rocks from the Yukon-Tanana The Chatanika terrane is a distinctive unit exposed in the northern part assemblage of rocks that is intercalated with metasedimentary units of the Brown, E.H., and Forbes, R.B., 1984, Paragenesis and regional significance Contains chlorite and calcite amygdules. Strong culumnar jointing metamorphic derivation. terrane suggests that some of the protoliths may be as old as Late of the Fairbanks mining district. The sequence includes type C eclogites Fairbanks schist unit (fig. 2, sheet 2). The Cleary sequence is composed of of eclogitic rocks from the Fairbanks district, Alaska [abs.]: Program developed at Brown's Hill. Precambrian (Aleinikoff and others, 1981; and Aleinikoff and Nokleberg, (Coleman and others, 1965) and high-grade metamorphic rocks including 2) An episode of quartz veining introduced pyrite-arsenopyrite calcareous actinolitic greenschist and chlorite schist with interlensed with abstracts, Geological Society of America Cordilleran Section 1989). K-Ar ages from metamorphic and igneous rocks range between Location of geochemical rock sample. See sheet 2 for analytical results. garnet-bearing biotite-muscovite schist, impure marble, black quartzite, and **Metamorphic Rocks** Meeting, Anchorage, May 1984. potassium feldspar-quartz schist (metarhyolite) and muscovite quartz schist mineralization with minor free gold. amphibolite (Swainbank, 1970; Swainbank and Forbes, 1975). Amphibolite (metafelsic tuff). The metarhyolite and metafelsic tuff intervals host most of Chapman, R.M., and Foster, R.L., 1969, Lode mines and prospects in the Structural and stratigraphic evidence indicates that greenschist-facies from the Chatanika has been yielded an Ordovician K-Ar age (Forbes and Fairbanks district, Alaska: U.S. Geological Survey Professional Report Birch Hill sequence the known gold, arsenic, and antimony deposits in the Fairbanks mining 3) Bonanza-type polymetallic mineralization is linked to a third schists in the Circle and Livengood districts, northeast and northwest, episode of fine-grained quartz mineralization, including sulfide respectively, of the Fairbanks district, include recrystallized Late district, whereas the calcareous actinolitic greenschist and graphitic schist Chappell, B.W., and White, A.J.R., 1974, Two contrasting granite types: and sulfosalt mineralization consisting of pyrite, arsenopyrite, The Birch Hill sequence crops out in a narrow belt of rocks in the intervals are host to significant base and precious-metal enriched massive-Precambrian and lower Paleozoic sediments. Poorly preserved Paleozoic argentiferous Pb-Sb sulfosalts, sphalerite, galena, tetrahedrite, ECLOGITIC ROCKS - Three distinct type of eclogitic rocks Pacific Geology, v. 8, p. 173-174. southern part of the Fairbanks mining district. The unit consists of phyllite, sulfide accumulations. The Cleary sequence also contains variable amounts fossils have also been recovered from incompletely recrystallized calcschist occur, including: (1) garnet-clinopyroxene bearing rocks in Coleman, R.G., Lee, D.E., Beatty, L.B., and Brannock, W.W., 1965, of chlorite schist and impure marble. Felsic schist and micaceous quartzite pyrargyrite, and stannite. Free gold occurs in quartz and silver micaceous calc-schist, calc-amphibolite, quartzite, and minor felsic tuff. Unit and marble in the Big Delta and Eagle Quadrangles (Weber and others, and is largely associated with Pb-Sb sulfosalts. The bonanza-type mylonitic, layered, laminated, and massive varieties; the contains lower-greenschist-facies mineral assemblages and may be units that are geologically mapped as part of the Cleary sequence can be Eclogites and eclogites: their differences and similarities: Geological occurrence of pale-pink pyrope garnet and pale-green omphacitic Society of America Bulletin, v. 76, p. 483-508. assemblage in the Cleary Summit area overprints early quartz correlative with the Keevy Peak Formation of the central Alaska Range. Mesozoic sedimentary rocks are relatively rare in the Yukon-Tanana recognized by the presence of clear or yellow muscovite and quartz. pyroxene are characteristic of this variety; (2) garnet-Dusel-Bacon, Cynthia, Stern, T.W., Foster, H.L., and Bentz, J.L., 1979, veining but is not spatially restricted to the quartz-bearing Upland. However, Cretaceous argillaceous sandstone, graywacke, and clinopyroxene-amphibole bearing rocks that occur mainly as Pabes CALC-SCHIST - Light- to dark-brown, fine- to medium-grained, Preliminary results of an augen gneiss study, Big Delta Quadrangle, in CALCAREOUS ACTINOLITIC GREENSCHIST - Dark-green conglomerate of the Wilber Creek unit (Weber, 1989) have been mapped in to green, fine- to medium-grained, thinly laminated to massively thinly laminated and massive varieties, characterized by the Johnson, K.M., and Williams, J.R., eds., The United States Geological ly laminated muscovite- biotite calc-schist. the Livengood district, northwest of Fairbanks. presence of zoned garnet, light-green poikioblastic pyroxene, and 4) Late monomineralic veins with stibnite occur in gash veins and in bedded, calcareous actinolitic greenschist composed of actinolitic Survey in Alaska, Accomplishments during 1978: U. S. Geological Small areas of tholeiitic basaltic rocks, including pillow basalts, pleochroic light-green amphibole; (3) garnet-amphibole rocks isolated podiform lenses. Post mineralization faulting offsets vein Survey Circular 804-B, p. B57-B59. CALC-AMPHIBOLITE - Green to dark-green, fine- to mediumhornblende, garnet, and minor calcite, plagioclase (An₅₋₁₅), subaerial flows, and breccias, occur in the Fairbanks district (Birch Hill massive and poorly foliated; the garnets contain euhedral Forbes, R.B., 1982, with contributions from F.R. Weber, R.C. Swainbank, grained, thinly laminated to massive siliceous calc-amphibolite. clinozoisite, magnetite, pyrrhotite, and other sulfide minerals. systems throughout the district. basalt). Whole-rock K-Ar age determinations indicate that the Birch Hill Syngenetic(?) zinc, lead, silver, and gold mineralization is present in The protolith for the actinolitic greenschist was probably a basalt J.M. Britton, and J.M. Brown, Bedrock geology and petrology of the Unit contains gray to tan and green fine-grained, thinly laminated overgrowths on subhedral cores. basalt is Tertiary. Silicified Metasequoia trunks and branches present in a calcareous actinolitic greenschist (metamafic tuff) and graphitic and Fairbanks mining district: Alaska Division of Geological and fossil soil zone between the schists and overlying basalts on Birch Hill are IMPURE MARBLE - Light- to dark-gray, coarse-grained, Geophysical Surveys Open-file Report 169, 68 p. manganiferous schist (metachert) near the base of the Cleary sequence also believed to be of early or middle Tertiary age. massively bedded, light-brown weathering marble. Marble CHLORITE SCHIST - Dark-green to green, fine-grained, thinly PHYLLITIC SILTSTONE - Dark-gray to black, very fine Foster, H.L., 1970, Reconnaissance geologic map of the Tanacross Tertiary sedimentary rocks, including siltstone, sandstone, and (fig. 2 sheet 2) in the Cleary Summit area. The massive sulfide horizons contains minor clinopyroxene (diopside?), garnet, amphibole, rained, thinly bedded phyllitic siltstone. Includes dark-gray to minated, well-foliated, chlorite schist composed of chlorite, Quadrangle, Alaska: U.S. Geological Survey Miscellaneous conglomerate, occur in small, isolated basins throughout the Yukon-Tanana contain variable amounts of pyrite, sphalerite, galena, arsenopyrite, plagioclase (An5-15), epidote, calcite and quartz. Interbedded with brown fine-grained quartzite; dark-gray to black thin-bedded Investigations Map I-593, scale 1:250,000, 1 sheet. jamesonite, boulangerite, and stibnite. Locally, the massive sulfide Upland. All occurrences are nonmarine, and some sections contain coal and slate; and minor light-brown to buff fine-grained felsic tuff. the chlorite schist are dark-gray to black, very fine grained, thinly Foster, H.L., Weber, F.R., and Dusel-Bacon, Cynthia, 1977, Gneiss dome in mineralization is sheared and remobilized into discordant shear zones. CALCAREOUS MUSCOVITE SCHIST - Light-brown, to redbedded metachert layers. The protolith for the chlorite schist was the Big Delta C-4 Quadrangle, Alaska: U.S. Geological Survey Open-Large Cretaceous and Tertiary volcanic fields dominated by felsic An intrusive-hosted gold deposit 'Fort Knox,' occurs near the brown, fine-grained, thinly laminated, schist with calcite, quartz, volcanic rocks (including welded tuffs) have been mapped in the Tanacross file Report 77-262, scale 1:63,360, 1 sheet. confluence of Monte Cristo and Melba Creeks and north of Gilmore Dome. probably a mafic tuff. muscovite biotite, garnet, and pyrite. Chena River sequence Foster, H.L., Weber, F.R., Forbes, R.B., and Brabb, E.E., 1973, Regional This deposit may prove to be one of the largest gold-bearing mineralized and Big Delta Quadrangles by Foster (1970) and Bacon (1990, in press). POTASSIUM FELDSPAR-BEARING WHITE-SCHIST - Lightsystems yet discovered in the Fairbanks district. The Fort Knox deposit is geology of the Yukon-Tanana Upland, Alaska, in Pitcher, M.G., ed., GARNET-FELDSPAR-MUSCOVITE-QUARTZ SCHIST Structurally above the Fairbanks schist-Cleary sequence is an interval of brown to light-gray and buff, fine- to medium-grained, thinly 1973, Arctic Geology: American Association of Petroleum Geologists hosted in west-northwest-trending mineralized zones that are localized in Regional Tectonic History variable thickness containing dense banded amphibolite, tremolite marble, Medium- to dark-gray, fine- to medium-grained porphyroblasic laminated quartz, muscovite, ± biotite, porphyroblastic schist. Memoir 39, p. 388-395. altered granodiorite-quartz monzonite. This type of gold mineralization may coarse-grained garnet-muscovite schist, biotite-rich schist, micaceous schist containing garnet porphyroblasts to 1 cm in diameter. Locally contains pink or light-gray porphyroblasts of potassium Furst, G.A., 1968, Geology and petrology of the Fairbanks basalts, be an important new exploration target in the Fairbanks district. The regional tectonic setting of the Yukon-Tanana Upland is calcschist, and pale-green metachert. Mineral assemblages and textural feldspar to 3 mm in diameter and embayed blastophenocrysts of Fairbanks, Alaska: Fairbanks, University of Alaska unpublished M.S. dominated by the Tintina and Denali faults. Both of these right-lateral advancement in these rocks suggest they were metamorphosed to lower-MUSCOVITE QUARTZITE - Dark-gray to black, fine-grained, quartz to 5 mm in diameter. The protolith for the potassium DESCRIPTION OF MAP UNITS strike-slip faults have large-scale displacements, bringing crustal blocks of quartzite. Unit contains garnet, biotite, chlorite, and graphite. feldspar-bearing white schist was probably a rhyolitic tuff. Hall, M.H., 1985, Structural geology of the Fairbanks mining district, central contrasting geology into juxtaposition (fig. 1, sheet 2). Alaska: Fairbanks, University of Alaska unpublished Master of Science Unconsolidated Deposits AMPHIBOLITE, CALC-AMPHIBOLITE, AND The Yukon-Tanana block (Yukon-Tanana terrane of Jones and others, MUSCOVITE QUARTZ SCHIST - Light-gray, yellow and buff, thesis, 68 p., 2 plates. GREENSTONE - Green to dark-green, medium- to coarse-Howell, D.G., Jones, D.L., and Schermer, E.R., 1985, Tectonstratigraphic fine- to very fine grained, muscovite, albite ± tourmaline, zircon, 1987) is bounded on the northeast by the Tintina fault and on the southwest Qel LOESS (WINDBLOWN SILT) - Medium light-brown to buff, grained, massive to thinly laminated amphibolite containing by the Denali fault (fig. 1, sheet 2). It is bounded to the northwest by the and potassium-feldspar, quartz schist. The unit may grade upward terranes of the circum-Pacific region. in Howell, D.G., ed., very fine grained, well-sorted, silty material deposited on hilltops hornblende, plagioclase, quartz, garnet, calcite, epidote, and Manley terrane and on the southeast by the Stikine terrane (Jones and into a thinly laminated quartzite (metachert?) in the Cleary Tectonostratigraphic terranes of the circum-Pacific region: Houston, and on upper and middle slopes. May contain organic material others, 1987; and Howell and others, 1985). biotite with accessory sphene, rutile, apatite, magnetite, and Summit area. Protolith for the muscovite quartz schist was Texas, Circum-Pacific Council for Energy and Mineral Resources, p. 3locally, especially in lower slope regions where it has been zircon. Banded varieties probably are recrystallized mafic tuffs, The oldest structural grain in the Yukon Tanana block trends to the probably a felsic pyroclastic or an exhalite. reworked by slope processes and mixed with organic material of northwest, but a superimposed northeast trend becomes increasingly whereas massive amphibolites appear to represent Jones, D.L., Silberling, N.J., Coney, P.J., and Plafker, George, 1987, the lower slope and valley areas. metamorphosed tholeitic mafic flows. dominant to the northwest. Folds with north-vergent axial planes and Lithotectonic terrane map of Alaska (west of the 141st Meridian): U.S. northeast-trending axes transect the older structural grain at about 60°. The Geological Survey Miscellaneous Field Studies Map MF-1874-A, scale DREDGE TAILINGS - Coarse- to very coarse grained, well-TREMOLITE MARBLE - White to pale-green, medium- to later deformational episode occurred about 90 to 120 m.y., in the Fairbanks sorted gravel. Occurs in irregular, steep piles that are the result oarse-grained tremolite marble. Unit is highly deformed and is area and was associated with the emplacement of mesozonal synkinematic Koschmann, A.H. and Bergendahl, M.H., 1968, Principal gold-producing a distinctive marker horizon in the Chena River sequence. It districts of the United States: U.S. Geological Survey Professional plutons and the formation of epigenetic ore deposits (Blum, 1983; Metz and occurs in most exposures of the sequence throughout the district. Hamil 1986: Metz and others 1987: and Metz. 1987). Thicker exposures of this unit near Fox have been quarried for Recent geologic mapping (Weber and others, 1978) and aeromagnetic Mertie, J.B., Jr., 1937, The Yukon-Tanana region: U.S. Geological Survey studies show that the Yukon-Tanana block is transected by several dimension and decorative stone. Bulletin 872, 276 p. ALLUVIUM - Very fine to coarse-grained, well-sorted silt, sand, northeast-trending faults. Several of these including the Shaw and Mansfield and gravel deposited by rivers and streams. Silt and sand layers Metz, P.A., 1987, Ore mineralogy and gold grain distribution in the gold-PELITIC SCHIST - Dark green-brown, brown, and light-brown, Creek faults, show left-lateral offsets and appear to be large-scale may contain organic material. Gravel and organic-rich finer silver-arsenic-antimony-tungsten mineralization of the Fairbanks mining arse-grained muscovite- biotite-garnet-quartz schist. Biotite dislocations related to a possible shear couple between a locked or relatively grained deposits may be perennially frozen (permafrost). district, Alaska; in Vassiliou, A.H., Hausen, D.M., and Carson, D.J.T., slow-moving Tintina fault and more active displacement along the Denali rosettes are common. Distinguished from pelitic schist of the eds., Process Mineralogy VII: Application to mineral beneficiation Fairbanks Schist unit by its silvery appearance, coarse grains, REWORKED SILT - Dark-brown to black, very fine grained, technology and mineral exploration, with special emphasis on 147° 53' 45" / folded muscovite plates and brown garnet. organic-rich, valley-bottom accumulations of reworked loess disseminated carbonaceous gold ores: American Institute of Mining GEOLOGY OF THE FAIRBANKS MINING DISTRICT (silt). May contain discontinuous layers and lenses of sand and Engineers, Metallurgical Society annual meeting, February 1987, p. 247-METACHERT - Pale-green, gray, and brown, thinly banded gravel. High organic content results in poorly drained, marshy netachert and calc-silicate beds with appreciable amounts of The Fairbanks district is well known as one of the most important gold conditions in summer. Zones of discontinuous permafrost Metz, P.A., and Hamil, B.M., 1986, Origin and extent of the gold, silver, diopside and vesuvianite. Siliceous calc-silicate beds and greenishproducing areas in Alaska. Since Felix Pedro's initial discovery in 1902, the antimony, and tungsten mineralization in the Fairbanks mining district; banded fine-grained metacherts are ubiquitous lithologies in the Fairbanks mining district has produced over 7.6 million troy ounces of gold, in Hagni, R.D., ed. Process Mineralogy VI: Application to precious mainly from placer deposits. This production accounts for 25 percent of PEAT - Dark-brown to black, very organic rich valley-bottom metals deposits, industrial minerals, coal, liberation, mineral processing, Alaska's total production. The district has also produced significant accumulations. Perennially frozen and contains high ice content. agglomeration, metallurgical products, and refractories, with special CHENA SEQUENCE UNDIFFERENTIATED. amounts of antimony, tungsten, building stone, and aggregate. emphasis on cathodoluminescence microscopy: American Institute of Bedrock exposed in the district comprises three metamorphosed Mining Engineers, Metallurgical Society annual meeting, March 1986, stratigraphic packages, all in apparent thrust-fault contact. From oldest to youngest they are the Chatanika terrane, Fairbanks schist unit, Chena River Metz, P.A., Freeman, C.J., and Calvin, J.S., 1987, Bulk mineable vein and Intrusive rocks in the district occur mainly as northeasterly trending sequence, and the Birch Hill sequence. bodies of dark-gray to gray, fine- or medium-grained hornblende-bearing disseminated gold mineralization of the Fairbanks mining district, The Chatanika terrane occurs in the northern part of the district and granodiorite exposed near Pedro Dome, near Twin Creek, and near Monte Alaska; in Proceedings of Pacific Rim Congress 87: Australian Institute structurally overlies the Fairbanks schist unit in presumed thrust contact. It of Mining and Metallurgy, Victoria Australia, p. 333-342. Cristo Creek in the northern part of the district and near Eva Creek on consists of eclogitic variants, garnet amphibolite, black quartzite, and pelitic Pèwè, T.L., Bell, J.W., Forbes, R.B., and Weber, F.R., 1976, Geologic map Ester Dome in the southwestern part of the district. The second dominant schist of epidote-amphibolite- and garnet-amphibolite-facies metamorphic of the Fairbanks D-2 SE Quadrangle, Alaska, scale 1:24,000, 1 sheet. intrusive rock type in the district consists of light-gray, coarse-grained, grade (Swainbank, 1970; Swainbank and Forbes, 1975; Brown and Forbes, Swainbank, R.C., 1970, Geochemsitry and petrology of ecologitic rocks in multiphase porphyritic quartz monzonite-granite that occurs on Gilmore the Fairbanks area, Alaska: Fairbanks, University of Alaska, The Fairbanks schist unit is the dominant rock unit exposed in the unpublished Ph.D. thesis, 130 p. Fairbanks mining district and consists of brown- to gray-quartzite and ALTERED INTRUSIVE ROCKS - Light- to dark-gray, buff and Swainbank, R.C., and Forbes, R.B., 1975, Petrology of ecologitic rocks from muscovite-quartz schist with local variants containing garnet, biotite and brown, fine grained, locally porphyritic dikes, plugs, and breccia the Fairbanks area, Alaska: Geological Society of America Special chlorite. Mineral assemblages in this 1,200 m-thick unit are indicative of dikes. Highly altered. Contain disseminated sulfides. Paper 151, p. 77-214. greenschist-facies metamorphic grade. Interstratified near the center of the Weber, F.R., 1989, Geology between Fairbanks and the Yukon River, east-Fairbanks schist unit is a sequence of variable thickness that contains APLITE PEGMATITE DIKES - Light-gray to gray and tan, finecentral Alaska; in Schmidt, R.A.M., Nokleberg, W.J., and Page, R.A., interlensing felsic schist, laminated white micaceous quartzite, chloritic and to very coarse-grained aplite. Commmonly found adjacent to eds., 1989, Alaska Geological and Geophysical Transect, Field Trip actinolitic greenschist, graphitic schist, minor metabasite and metarhyolite, porphyritic phases of granodiorite and quartz monzonite. Aplite Guidebook T104: American Geophysical Union, p. 84-95. calc-silicates, banded gray marble, and significant amounts of quartzite and composed of potassium feldspar (36 percent), quartz Weber, F.R., Foster, H.L., Keith, T.E.C., and Dusel-Bacon, Cynthia, 1978, muscovite-quartz schist. This unit, known as the Cleary sequence (fig. 2, (31 percent), plagioclase (30 percent), muscovite (1 percent), and Preliminary geologic map of the Big Delta Quadrangle, Alaska: U.S. sheet 2), may be largely of distal volcanogenic origin. Geological Survey Open-file Report 78-529A, scale 1:250,000, 1 sheet. accessory garnet, sphene, apatite, zircon, and rutile (2 percent). Structurally above the Fairbanks schist - Cleary sequence is the Chena Unit contains large euhedral grains of arsenopyrite and pyrite in River sequence, a unit of variable thickness containing dense banded the Gilmore Dome pluton. amphibolite, tremolite marble, coarse-grained garnet muscovite schist, biotite-rich schist, micaceous calcschist and pale green metachert. Mineral QUARTZ MONZONITE-GRANITE - Medium- to light-gray, assemblages and textural maturity indicate lower amphibolite facies medium- to coarse-grained, porphyritic quartz monzonite-granite. metamorphic grade. Dominant rock type in the Gilmore Dome pluton. Composed of Stratigraphically overlying the Chena River sequence in the southern plagioclase (An₂₃₋₄₇)(36 percent), phenocrystal and glomeropart of the distict is the Birch Hill sequence consisting of phyllitic siltstone, porphyritic quartz (30 percent), potassium feldspar (28 percent), calc-schist, calc-amphibolite, quartzite and minor felsic tuff. The unit is biotite (4 percent), and accessory muscovite, sphene, apatite, intruded by and is overlain by basalts of Late Cretaceous or Tertiary age. zircon, and rutile (4 percent). Porphyritic phases contain coarse subhedral to euhedral phenocrysts of orthoclase that compose up Table 1 (sheet 2) lists the results of major-oxide chemical analyses of samples of various metamorphic rock types in the Fairbanks district. These to three-eighths of the rock. analyses reflect a wide range of chemical compositions contained within the individual metamorphic rock packages. Table 2 (sheet 2) contains trace-element contcentrations for the same CORRELATION OF MAP UNITS metamorphic rock samples contained in table 1. These data reveal the high trace-metal content of rocks in the Cleary sequence, particularly with Unconsolidated Deposits respect to gold, arsenic, and antimony concentrations contained in representative metavolcanic rock units. Trace-element concentrations in samples of skarns and hornfels in table 2 are high possibly because the samples, which are part of the Cleary sequence may reflect original trace metal concentrations in these rocks prior Igneous Rock Units Intrusive igneous rocks in the Fairbanks district occur mainly as northeasterly trending bodies of multiphase, dark-gray, fine- to mediumgrained porphyritic and equiganular, hornblende-bearing granodiorite exposed near Pedro Dome, near Twin Creek, near Monte Cristo Creek in the northern part of the district; and near Eva Creek on Ester Dome in the southwestern part of the district. Light-gray, coarse-grained, multiphase porphyritic quartz monzonite-granite is the dominant rock type on Gilmore Dome, in the central part of the map area. Numerous small plutons or hypabyssal bodies of felsic to intermediate composition occur throughout the district; their age and relationship to the larger intrusions are not 148° 15' 00" Field and geochemical evidence suggests a mesozonal level of emplacement for the large intrusives near Pedro and Gilmore Domes (Blum, 1983). Cross-cutting relationships on Gilmore Dome and at Twin Creek indicate that the porphyritic quartz monzonite-granite is younger than the hornblende-bearing granodiorite. Inclusions of granodiorite in quartz monzonite-granite at Gilmore Dome also support this interpretation. Available K-Ar ages for granodiorite of the Pedro Dome stock range from Chena River 91 to 93 m.y. (Blum, 1983). Isotopic data have yielded a Rb-Sr isochron age of 91 Ma for samples from the Pedro and Gilmore Dome stocks (table 3, sheet 2). Figure 3 (sheet 2) is a Rb-Sr isochron diagram for intrusive rock LOCATION INDEX samples from the Fairbanks mining district. The slope of the isochron and therefore the apparent age and initial 87Sr/86Sr ratio of the samples are constrained by a single analysis of a sample from an aplite dike from Gilmore Dome. Any variance in the 87Sr/86Sr ratio of that sample will greatly affect the apparent age and initial 87Sr/86Sr ratio given by the isochron. Further work on the age of the intrusives within the district is Petrochemical and mineralogical criteria suggest the quartz monzoniticgranitic rocks may be S and I type granitic rocks (Chapel and White, 1974), whereas the hornblende-bearing granodiorite has characteristics of I-type intrusives. Table 4 (sheet 2) lists major-oxide chemical analyses and normative mineral compositions for intrusive igneous rocks in the district. Figure 4 (sheet 2) shows the location of samples. The regional structural evolution of the Fairbanks area is dominated by at least two episodes of folding. The first resulted in synmetamorphic, overturned to recumbent, subisoclinal, northeast-verging folds with wavelengths to about 300 m and northwest trending axes. The second event folded the previously metamorphosed units into a series of broad northeasttrending open folds (Swainbank, 1970; Hall, 1985). Local structures include small-scale folds, faults, joints, shears, and 'crush zones,' which typically cluster in north-south and east-west trending subparallel sets and are variable in length up to 1.2 km long. Both sets of crush zones have a close spatial and genetic relationship to discordant gold, antimony, and arsenic Figure 5 (sheet 2) shows the distribution and orientation of 24 vein systems in the Ester Dome area. The vein systems generally trend between **CROSS SECTIONS** N. 30 W. and N. 30 E. and dip relatively steeply to the east and west. The vein systems appear to cluster in distinct areas which may be due to intrusive centers beneath them. For example, the vein cluster near the Ryan Mine (fig. 5, sheet 2) occurs just north of a recently recognized mineralized intrusive body composed of variably altered and sheared hornblende granodiorite(?) and granite (?). The intrusion is cut by a well-developed stockwork of quartz veinlets, some of which contain chlorite and white mica selvages, arsenopyrite, antimony, and gold. Several other vein clusters may reflect undiscovered intrusions at depth. Figure 6 (sheet 2) shows the distribution of 31 vein systems east of the Cleary Summit area in the northern part of the district. Most of the historical lode production of precious metals and antimony (Chapman and No Vertical Exaggeration Foster, 1969) in the Cleary Summit area has come from vein systems that occur along the northern limb of the assymetical east-northeast-trending Cleary anticline (informal nomenclature, this report). These vein systems

BEDROCK GEOLOGY OF THE FAIRBANKS MINING DISTRICT

ITARY RESERVATION

Approximate Mean Declination, 1975

SCALE 1:63,360

CONTOUR INTERVAL 100 FEET, LIVENGOOD QUADRANGLES

DATUM IS MEAN SEA LEVEL

50 FEET, FAIRBANKS QUADRANGLES

Geology by M.S. Robinson, T.E. Smith, P.A. Metz, and T.K. Bundtzen, 1981.

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Larson. Cartography by Robinson, Laird, and A.G. Sturmann.

appear to be conjugate shears that formed as a result of fracturing near the crest of the Cleary anticline. Although the vein systems in the Cleary Summit area also exhibit distinct clustering, as in the Ester Dome area, they appear to be concentrated near culminatons and depressions along the axis of the Cleary anticline (R.C. Swainbank, personal commun., 1990). The culminations and depressions manifest themselves as b lineations (trend and plunge of the axial trace of small crenulations) in the plane of strike and dip of schistosity and may reflect crossfolding and resultant 'egg crate' style

Field relations and structural fabric orientations (Hall, 1985) suggest

that the Fairbanks schist structurally underlies the Chena River sequence

and Chatanika terrane. Intrafolial folds, intensely flattened crenulation cleavage, and recrystallized porphyroblasts demonstrate the intensity of deformation associated with second-generation (F₂) folding along northeast

Base modified from U.S. Geological Survey Fairbanks D-1, 1975, Fairbanks D-2, 1975, Fairbanks D-3, 1972, Livengood A-1, 1952, and

Topography, by photogrammetric methods from aerial photographs taken in 1949, 1951, 1954, 1972, and 1975.

Livengood A-2, 1952 Quadrangles, Alaska

Maps not field checked.

No Vertical Exaggeration

No Vertical Exaggeration