

U.S. Geological Survey Reports on the Tintina Gold Province—Products of Recent Mineral Resources Program Studies

By Larry P. Gough

Chapter K of

**Recent U.S. Geological Survey Studies in the Tintina Gold Province,
Alaska, United States, and Yukon, Canada—Results of a 5-Year
Project**

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- Crock, J.G., Briggs, P.H., Gough, L.P., Wanty, R.B., and Brown, Z.A., 2007, Regional geochemical results from the reanalysis of NURE stream sediment samples—Eagle 3° quadrangle, east-central Alaska: U.S. Geological Survey Open-File Report 2007–1075, available only online at <http://pubs.usgs.gov/of/2007/1075/>. (Accessed August 13, 2007.)
- Crock, J.G., Seal, R.R., II, Gough, L.P., and Weber-Scannell, P., 2003, Results of elemental and stable isotopic measurements, and dietary composition of Arctic grayling (*Thymallus arcticus*) collected in 2000 and 2001 from the Fortymile River watershed, Alaska: U.S. Geological Survey Open-File Report 03–057, 28 p. (Also available online at <http://pubs.usgs.gov/of/2003/ofr-03-057/>.)
- Day, W.C., Aleinikoff, J.N., Roberts, Paul, Smith, Moira, Gamble, B.M., Henning, M.W., Gough, L.P., and Morath, L.C., 2003, Geologic map of the Big Delta B–2 quadrangle, east-central Alaska: U.S. Geological Survey Geologic Investigations Series I–2788, 1 map plus text. (Also available online at <http://pubs.usgs.gov/imap/i-2788/>.)
- Day, W.C., O’Neill, J.M., Aleinikoff, J.N., Green, G.N., Saltus, R.W., and Gough, L.P., 2007, Geologic map of the Big Delta B–1 quadrangle, east-central Alaska: U.S. Geological Survey Scientific Investigations Map I–2975, scale 1:63,360. (Also available online at <http://pubs.usgs.gov/sim/2007/2975/>.)
- Dusel-Bacon, Cynthia, and Harris, A.G., 2003, New occurrences of late Paleozoic and Triassic fossils from the Seventymile and Yukon-Tanana terranes, east-central Alaska, with comments on previously published occurrences in the same area, in Galloway, J.P., ed., Studies by the U.S. Geological Survey in Alaska, 2001: U.S. Geological Survey Professional Paper 1678, p. 5–30. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1678>.)
- Dusel-Bacon, Cynthia, Hopkins, M.J., Mortensen, J.K., Dashevsky, S.S., Bressler, J.R., and Day, W.C., 2006, Paleozoic tectonic and metallogenic evolution of the pericratonic rocks of east-central Alaska and adjacent Yukon, in Colpron, Maurice, and Nelson, J.L., eds., Paleozoic evolution and metallogeny of pericratonic terranes at the ancient Pacific margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada, Special Paper 45, p. 25–74.
- Dusel-Bacon, Cynthia, Mortensen, J.K., and Fredericksen, R., 2003, Cretaceous epigenetic base-metal mineralization at the Lead Creek prospect, eastern Yukon-Tanana Upland, Alaska; Constraints from U-Pb zircon dating and Pb-isotopic analyses of sulfides, in Galloway, J.P., ed., Studies by the U.S. Geological Survey in Alaska, 2001: U.S. Geological Survey Professional Paper 1678, p. 31–40. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1678>.)
- Dusel-Bacon, Cynthia, Slack, J.F., and Belkin, H.E., 2007, The magmatic to hydrothermal transition in peralkaline-hosted VMS systems—An example from the Bonfield district, east-central Alaska, USA, in Andrew, C.J., ed., Proceedings of the 9th Biennial Meeting of the Society for Geology Applied to Mineral Deposits, August 20–23, 2007, Mineral Exploration and Research: Dublin, Ireland, Irish Association for Economic Geology, v. 2, p. 1045–1048.

¹U.S. Geological Survey.

K2 Recent U.S. Geological Survey Studies in the Tintina Gold Province, Alaska, United States, and Yukon, Canada

- Dusel-Bacon, Cynthia, Wooden, J.L., and Hopkins, M.J., 2004, U-Pb zircon and geochemical evidence for bimodal mid-Paleozoic magmatism and syngenetic base-metal mineralization in the Yukon-Tanana terrane, Alaska: *Geological Society of America Bulletin*, v. 116, no. 7–8, p. 989–1015.
- Dusel-Bacon, Cynthia, Wooden, J.L., and Layer, P.W., 2003, A Cretaceous ion-microprobe U-Pb zircon age for the West Point orthogneiss; Evidence for another gneiss dome in the Yukon-Tanana Upland, *in* Galloway, J.P., ed., *Studies by the U.S. Geological Survey in Alaska, 2001: U.S. Geological Survey Professional Paper 1678*, p. 41–60. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1678>.)
- Eppinger, R.G., Briggs, P.H., and Dusel-Bacon, Cynthia, 2004, Environmental geochemistry of an undisturbed volcanogenic massive sulfide deposit, Red Mountain, Bonnifield mining district, east-central Alaska, *in* Wanty, R.B., and Seal, R.R., II, eds., *Water-rock interaction, Proceedings of the 11th International Symposium on Water-Rock Interaction, Saratoga Springs, N.Y., June 22–July 2, 2004*: London, Taylor and Francis Group, p. 1483–1487.
- Eppinger, R.G., Briggs, P.H., Dusel-Bacon, Cynthia, Giles, S.A., Gough, L.P., Hammarstrom, J.M., and Hubbard, B.E., 2007, Environmental geochemistry at Red Mountain, an unmined volcanogenic massive sulfide deposit in the Bonnifield district, Alaska Range, east-central Alaska: *Geochemistry: Exploration, Environment, Analysis*, v. 7, no. 3, p. 207–223. (Also available online at <http://geea.geoscienceworld.org/cgi/content/abstract/7/3/207>.)
- Giles, S.A., Eppinger, R.G., Granitto, Matthew, Zelenak, P.P., Adams, M.G., Anthony, M.W., Briggs, P.H., Gough, L.P., Hageman, P.L., Hammarstrom, J.M., Horton, J.D., Sutley, S.J., Theodorakos, P.M., and Wolf, R.E., 2007, Geochemical data for stream-sediment, surface-water, rock, and vegetation samples from Red Mountain (Dry Creek), an unmined volcanogenic massive sulfide deposit in the Bonnifield district, Alaska Range, east-central Alaska: *U.S. Geological Survey Data Series DS-204*, 64 p. CD-ROM. (Also available online at <http://pubs.er.usgs.gov/usgspubs/ds/ds204>.)
- Goldfarb, R.J., Ayuso, R.A., Miller, M.L., Ebert, S.E., Marsh, E.E., Petsel, S.A., Miller, L.D., Bradley, D.C., Johnson, Craig, and McClelland, William, 2004, The Late Cretaceous Donlin Creek gold deposit, southwestern Alaska—Controls on epizonal ore formation: *Economic Geology*, v. 99, no. 4, p. 643–671.
- Goldfarb, R.J., Baker, Timothy, Dube, Benoit, Groves, D.I., Hart, C.J.R., and Gosselin, Patrice, 2005, Distribution, character, and genesis of gold deposits in metamorphic terranes, *in* Hedenquist, J.W., Thompson, J.F.H., Goldfarb, R.J., and Richards, J.P., eds., *One Hundredth Anniversary Volume of Economic Geology, 1905–2005*: Littleton, Colo., Society of Economic Geologists, p. 407–450.
- Gough, L.P., ed., 2004, Selected geochemical and biogeochemical studies of the Fortymile River watershed, Alaska: *U.S. Geological Survey Professional Paper 1685*, 54 p. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1685>.)
- Gough, L.P., Crock, J.G., Seal, R.R., II, Wang, Bronwen, and Weber-Scannell, Phyllis, 2004, Biogeochemistry, stable isotopic composition, and feeding habits of Arctic grayling (*Thymallus arcticus*) in the lower Fortymile River, eastern Alaska, *in* Gough, L.P., ed., *Selected geochemical and biogeochemical studies of the Fortymile River watershed, Alaska: U.S. Geological Survey Professional Paper 1685*, p. 21–43. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1685>.)
- Gough, L.P., Day, W.C., Crock, J.G., Gamble, B.M., Henning, M.W., Ager, C.M., Meier, A.L., Briggs, P.H., Brown, Z.A., and Adams, Monique, 2005, Regional geochemical results from the analyses of rock, soil, and vegetation samples—Big Delta B-2 quadrangle, Alaska: *U.S. Geological Survey Open-File Report 2005–1431*, 16 p., available only online at <http://pubs.usgs.gov/of/2005/1431/>. (Accessed August 13, 2007.)
- Gough, L.P., Eppinger, R.G., Briggs, P.H., and Giles, S.A., 2006, Biogeochemical characterization of an undisturbed highly acidic, metal-rich bryophyte habitat, east-central Alaska, USA: *Arctic, Antarctic, and Alpine Research*, v. 38, no. 4, p. 522–529.
- Gough, L.P., Wang, Bronwen, Smith, D.B., and Gustavsson, Nils, 2005, Geochemical landscapes of Alaska—New map presentations and interpretations for 23 elements in surficial materials: *U.S. Geological Survey Professional Paper 1716*, 36 p. (Also available online at <http://pubs.usgs.gov/pp/2005/1716>.)
- Groves, D.I., Goldfarb, R.J., Robert, Francois, and Hart, C.J.R., 2003, Gold deposits in metamorphic belts; overview of current understanding, outstanding problems, future research, and exploration significance: *Economic Geology*, v. 98, no. 1, p. 1–29.

- Hart, C.J.R., and Goldfarb, R.J., 2005, Distinguishing intrusion-related from orogenic gold systems, *in* Realising New Zealand's mineral potential, Proceedings of the Australian Institute of Mining and Metallurgy, 2005 New Zealand Minerals Conference, Auckland, New Zealand, November 13–16, 2005: Wellington, New Zealand, Ministry of Economic Development Crown Minerals Group, p. 125–133.
- Hart, C.J.R., Goldfarb, R.J., Lewis, L.L., and Mair, J.L., 2004, The northern Cordilleran mid-Cretaceous Plutonic province—Ilmenite/magnetite series granitoids and intrusion-related mineralization: *Resource Geology*, v. 54, no. 3, p. 253–280.
- Hart, C.J.R., Mair, J.L., Goldfarb, R.J., and Groves, D.I., 2004, Source and redox controls on metallogenic variations in intrusion-related ore systems, Tombstone-Tungsten belt, Yukon Territory, Canada, *in* Ishihara, Shunso, Stephens, W.E., Harley, S.L., Arima, Makoto, and Nakajima, Takashi, eds., Fifth Hutton Symposium on the Origin of Granites and Related Rocks, Proceedings, Toyohashi, Japan, September 2–6, 2003: Transactions of the Royal Society of Edinburgh, v. 95, parts 1–2, p. 339–356.
- Hart, C.J.R., Mair, J.L., Groves, D.I., and Goldfarb, R.J., 2003, The influence of source variations on redox state and metallogeny of a cross-orogen plutonic province, Yukon, Canada, *in* The origin of granites and related rocks, Hutton Symposium V: Geological Survey of Japan, Interim Report 29, 42 p.
- Hart, C.J.R., Villeneuve, M.E., Mair, J.L., Goldfarb, R.J., Selby, D., Creaser, R.A., and Wijns, C., 2004, The duration of magmatic-hydrothermal ore systems—Comparative U-Pb SHRIMP & TIMS, Re-Os and Ar-Ar geochronology of mineralizing plutons in Yukon and Alaska, *in* Muhling, T., and others, eds., SEG 2004—Predictive Mineral Discovery Under Cover, Extended abstracts: University of Western Australia Publication 33, p. 347–349.
- Hubbard, B.E., Rowan, L.C., Dusel-Bacon, Cynthia, and Eppinger, R.G., 2007, Geologic mapping and mineral resource assessment of the Healy and Talkeetna Mountains quadrangles, Alaska using minimal cloud- and snow-cover ASTER data: U.S. Geological Survey Open-File Report 2007–1046, 18 p. (Also available online at <http://pubs.usgs.gov/of/2007/1046/>.)
- Jia, Yiefei, Kerrich, Robert, and Goldfarb, R.J., 2003, Metamorphic origin of the ore-forming fluid for orogenic gold-bearing quartz vein systems in the North American Cordillera; Constraints from $\delta^{15}\text{N}$, δD , and $\delta^{18}\text{O}$: *Economic Geology*, v. 98, p. 109–123.
- Macalady, D.L., Ritter, Kaylene, Redman, A.D., and Skold, Magnus, 2004, Comparative characteristics of natural organic matter in the Fortymile River, Alaska, *in* Gough, L.P., ed., Selected geochemical and biogeochemical studies of the Fortymile River watershed, Alaska: U.S. Geological Survey Professional Paper 1685, p. 45–52. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1685>.)
- Mair, J.L., Goldfarb, R.J., Johnson, C.A., Hart, C.J.R., and Marsh, E.E., 2006, Geochemical constraints on the genesis of the Scheelite Dome intrusion-related gold deposit, Tombstone gold belt, Yukon, Canada: *Economic Geology*, v. 101, no. 3, p. 523–553.
- Marsh, E.E., Goldfarb, R.J., Hart, C.J.R., and Johnson, C.A., 2003, Geology and geochemistry of the Clear Creek intrusion-related gold occurrences, Tintina gold province, Yukon, Canada: *Canadian Journal of Earth Sciences*, v. 40, no. 5, p. 681–699.
- Mortensen, J.K., Dusel-Bacon, Cynthia, Hunt, Julie, and Gabites, Janet, 2006, Lead isotopic constraints on the metallogeny of middle and late Paleozoic syngenetic base metal occurrences in the Yukon-Tanana and Slide Mountain/Seventymile terranes and adjacent portions of the North American miogeocline, *in* Colpron, Maurice, and Nelson, J.L., eds., Paleozoic evolution and metallogeny of pericratonic terranes at the ancient Pacific margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada Special Paper 45, p. 261–279.
- Mueller, S.H., Goldfarb, R.J., Hart, C.J.R., Mair, J.L., Marsh, E.E., and Rombach, C.S., 2004, The Tintina gold province, Alaska and Yukon—New world-class gold resources and their sustainable development: *Australasian Institute of Mining and Metallurgy*, v. 5, p. 189–198.
- Mueller, S.H., Goldfarb, R.J., Miller, M.L., Munk, L.A., Sanzolone, R.F., Lamothe, P.J., Adams, Monique, Briggs, P.H., McClesky, R.B., and Theodorakos, P.M., 2003, Surface and ground water geochemistry near the Donlin Creek gold deposit, southwestern Alaska: U.S. Geological Survey Open-File Report 03–492, 37 p. (Also available online at <http://pubs.usgs.gov/of/ofr-03-492/>.)
- Mueller, S.H., Hart, C.J.R., Goldfarb, R.J., Munk, L.A., and Diment, R., 2004, Post-mining hydrogeochemical conditions, Brewery Creek gold deposit, central Yukon, *in* Emond, D.S., and Lewis, L.L., eds., Yukon exploration and geology 2003: Whitehorse, Yukon, Yukon Geological Survey, p. 271–280.

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- Nelson, J.L., Colpron, Maurice, Piercey, S.J., Dusel-Bacon, Cynthia, Murphy, D.C., and Roots, C.F., 2006, Paleozoic tectonic and metallogenetic evolution of pericratonic terranes in Yukon, northern British Columbia and eastern Alaska, *in* Colpron, Maurice, and Nelson, J.L., eds., Paleozoic evolution and metallogeny of pericratonic terranes at the ancient Pacific margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada Special Paper 45, p. 323–360.
- Oliver, D.H., and Dusel-Bacon, Cynthia, 2003, Kinematic analysis from tectonites in the northern part of the Big Delta quadrangle, east-central Alaska, *in* Galloway, J.P., ed., Studies by the U.S. Geological Survey in Alaska, 2001: U.S. Geological Survey Professional Paper 1678, p. 61–70. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1678>.)
- Piercey, S.J., Nelson, J.L., Colpron, Maurice, Dusel-Bacon, Cynthia, Simard, R.-L., and Roots, C.F., 2006, Paleozoic magmatism and crustal recycling along the ancient Pacific margin of North America, northern Cordillera, *in* Colpron, Maurice, and Nelson, J.L., eds., Paleozoic evolution and metallogeny of pericratonic terranes at the ancient Pacific margin of North America, Canadian and Alaskan Cordillera: Geological Association of Canada Special Paper 45, p. 281–322.
- Saltus, R.W., and Day, W.C., 2006, Gravity and aeromagnetic gradients within the Yukon-Tanana upland, Black Mountain tectonic zone, Big Delta quadrangle, east-central Alaska: U.S. Geological Survey Open-File Report 2006-1391, poster, available only online at <http://pubs.usgs.gov/of/2006/1391/>. (Accessed August 13, 2007.)
- Verplanck, P.L., Mueller S.H., Goldfarb, R.J., and Nordstrom, D.K., 2007, Elevated arsenic in ground water, Ester Dome (Alaska), *in* Cidu, R., and Frau, F., eds., Water in mining environments, Proceedings, International Mine Water Association Symposium, Cagliari, Italy, May 27–31, 2007: Cagliari, Italy, University of Cagliari, p. 473–477.
- Verplanck, P.L., Mueller, S.H., Goldfarb, R.J., Nordstrom, D.K., and Youcha, E.K., 2008, Geochemical controls of elevated arsenic concentrations in groundwater, Ester Dome, east-central Alaska: *Chemical Geology*, v. 255, no. 1–2, p. 160–172.
- Verplanck, P.L., Mueller, S.H., Youcha, E.K., Goldfarb, R.J., Sanzolone, R.F., McCleskey, R.B., Briggs, P.H., Roller, M., Adams, Monique, and Nordstrom, D.K., 2003, Chemical analyses of ground and surface waters, Ester Dome, central Alaska, 2000-2001: U.S. Geological Survey Open-File Report 2003–244, 40 p. (Also available online at <http://pubs.usgs.gov/of/2003/ofr-03-244/>.)
- Wang, Bronwen, Gough, L.P., Wanty, R.B., Vohden, Jim, Crock, J.G., and Day, W.C., 2006, Water and sediment chemical data and data summary of samples collected in 1999 and 2001 in the Goodpaster River basin, Big Delta B-2 quadrangle, Alaska: U.S. Geological Survey Open-File Report 2006–1131, 18 p. (Also available online at <http://pubs.usgs.gov/of/2006/1131/>.)
- Wang, Bronwen, Wanty, R.B., and Vohden, Jim, 2004, Geochemical processes and geologic framework influencing surface-water and sediment chemistry in the Fortymile River watershed, east-central Alaska, *in* Gough, L.P., ed., Selected geochemical and biogeochemical studies of the Fortymile River watershed, Alaska: U.S. Geological Survey Professional Paper 1685, p. 3–19. (Also available online at <http://pubs.er.usgs.gov/usgspubs/pp/pp1685>.)

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Year 2005. Principal Investigator: G. Lang Farmer. Affiliation: University of Colorado, Boulder. Title: Petrogenesis of Cretaceous, gold-related plutons, eastern Tintina Gold Province (TGP), Alaska and Yukon—implications for ore genesis and resource distribution in the northern Cordillera.

Year 2006. Principal Investigator: Thomas Trainor. Affiliation: University of Alaska, Fairbanks. Title: Controls on antimony speciation and mobility in Legacy Mine tailings environments—a case study of mineral occurrences in the Tintina Gold Province, Alaska and Yukon.