MINFILE
NTS 082ESE - GRAND FORKS

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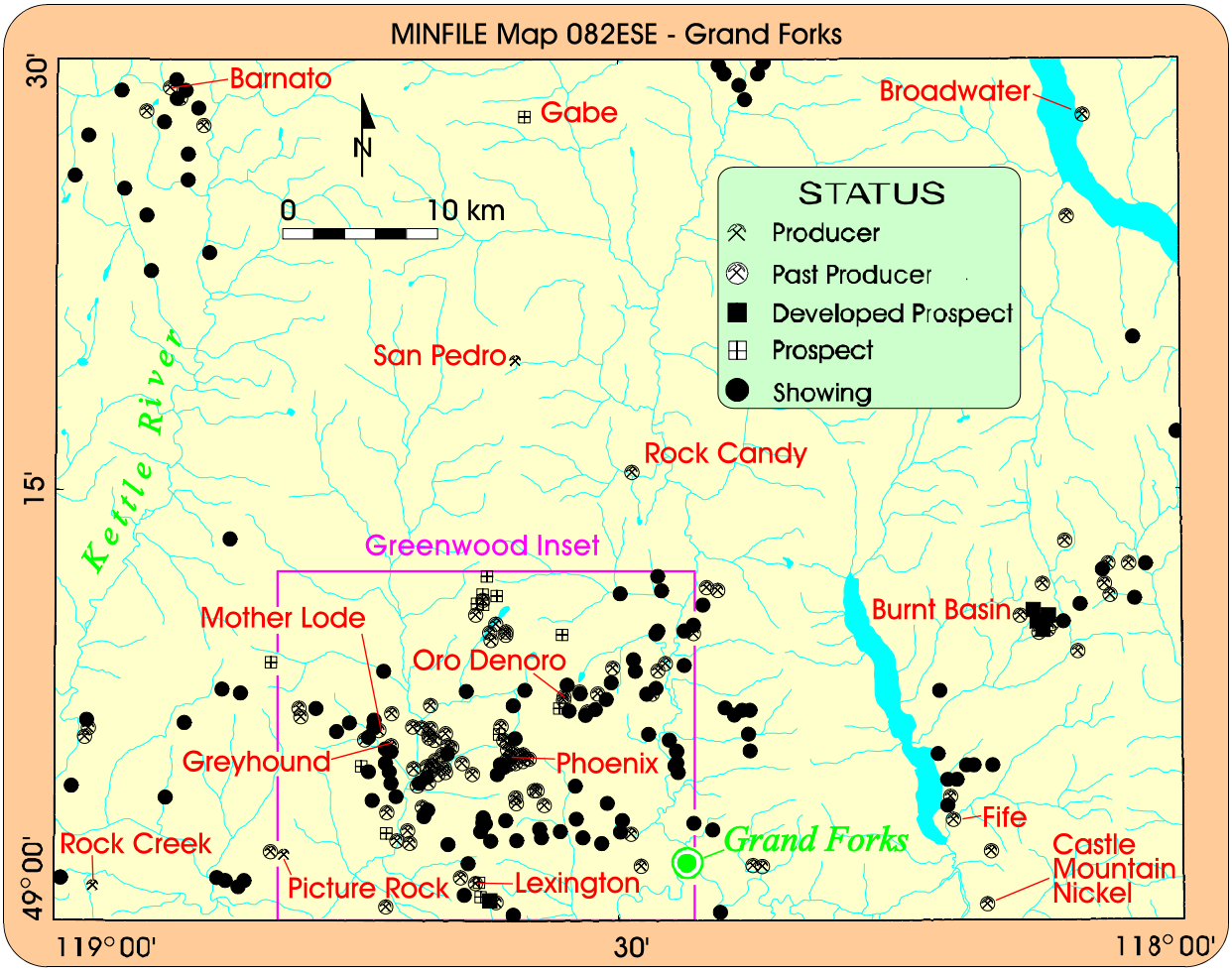
The Grand Forks map area, located in south-central British Columbia, contains 261 documented mineral occurrences, including 108 past producers. The map area includes the historically important Greenwood mining camp, which continues to attract exploration interest and activity. Physiographic domains include the Okanagan Highland over most of the map area, and the Selkirk Mountains to the east of Lower Arrow Lake. The map area lies in the Omineca tectonic belt, which formed in Early to Middle Jurassic time as a result of the accretion of Paleozoic and Mesozoic oceanic and arc rocks of the Slide Mountain and Quesnel terranes. These terranes were delaminated from the oceanic lithosphere and stacked against the continental margin of the North America craton. The resulting calc-alkaline plutonism created a large number of Middle Jurassic intrusions of intermediate composition. These intrude the accreted terranes and the Proterozoic pericratonic Monashee Complex. Overprinting by Cretaceous Laramide and post-Laramide Tertiary transtensional structures has complicated the geology.



Paleozoic age, unconformable bedded assemblages include the Knob Hill, Attwood and Anarchist groups. Knob Hill Group is Permo-Carboniferous, and possibly as old as Devonian, and consists of massive and banded

metacherts and lesser amounts of quartz chlorite schist, amphibolitic schists and gneisses, and limestone bands. The rocks have been affected by deformation and metamorphism causing recrystallization and the development of foliation, quartz sweats parallel to foliation and much deformation of individual beds. The Attwood Group is Permian and consists of black argillite, sharpstone conglomerate, greywacke, limestone lenses and metavolcanic units. The Anarchist Group comprises mostly undivided Knob Hill and Attwood formations. These groups are significantly folded, overturned and faulted. In the Greenwood area, splays or imbrications of the Chesaw fault comprise several separate belts of serpentinite, listwanite and metagabbro.

Mesozoic age rocks are represented by the Brooklyn Group, which is mid-Triassic and structurally overlies Knob Hill and Attwood sequences. It is characterized by thick basal sharpstone conglomerate, interfingering shales and limestones, and an upper sequence of volcanic breccias. Abundant chert clasts derived from the underlying Knob Hill characterize both the Attwood and Brooklyn sharpstone conglomerates. Both Attwood and Brooklyn rocks were affected by chlorite and amphibole grade regional metamorphism and important tectonic movements. Locally this deformation resulted in the development of thrust faults, along with tight recumbent and overturned folds.

The Eocene Penticton Group is the youngest assemblage in the area. This group comprises the Kettle River Formation consisting mostly of arkosic sandstones, and the Marron Formation consisting of three volcanic members - the Yellow Lake mafic phonolites, the Nimpit Lake tan trachytes, and the Park Rill andesites. These rocks have been tilted by block faulting related to graben development.

The igneous intrusions range from ultramafic rocks to an assortment of granite to syenite and diorite plutonic rocks and related hypabyssal bodies. Ages range from Triassic to Tertiary. The oldest intrusions are hetrogeneous hornblende diorites/gabbros locally referred to as the 'Old Diorite' unit. These rocks occur as numerous small, stock-like bodies that are associated with major faults scattered across the central part of the Greenwood mining area. Partially digested xenoliths of Attwood sedimentary and volcanic rocks are common in the diorite, suggesting a late Paleozoic or early Mesozoic age. Clasts of this diorite are found in the Brooklyn sharpstone conglomerate, proving a pre-Middle Triassic age for this intrusive rock. Serpentinized ultramafic rocks are also widely distributed throughout the area. These rocks are often associated with the 'Old Diorite' unit. The serpentinite was emplaced as lenses and sill-like bodies, probably in semi-sold state, along unconformity surfaces and in major fault zones. The mid-Jurassic Nelson intrusions, composed mainly of porphyritic granite and granodiorite, occur as a large body east of the Kettle Fault and smaller bodies scattered in other parts of the map area. The Greenwood and Wallace Creek plutons are biotite-hornblende granodiorite bodies, which are associated with many of the skarns and quartz veins in the area. Potassium/argon analyses of these rocks yield late Jurassic/early Cretaceous ages. Plutonism during the Cretaceous and continuing into the Tertiary resulted in granites and granodiorites of the extensive Okanagan Batholith, including the Valhalla and Ladybird intrusions. Microdiorite intrusions are widely scattered across the area occurring as small stocks and feeder dikes to the Eocene age Park Rill andesite lavas and older Triassic andesitic assemblages. The Coryell intrusions are among the youngest igneous rocks in the area forming small stocks, dikes and sills on fault zones and unconformities; these instrusions are feeders for the Eocene age Marron volcanic rocks.

The oldest rocks, in the central part in the map area, are the Upper Proterozoic Grand Forks Gneiss/Monashee Gneiss. These pericratonic rocks are part of the Shuswap Metamorphic Complex, which is a north-trending, raised fault block of high-grade metamorphic rocks. The rocks consist of biotite, amphibole, and pyroxene schists and gneisses, interlayered with pegmatites and leucogranite, with minor quartzites and calcareous rocks. These rocks are cut by north trending quartz monzonite dykes, and stocks and dykes and small stocks of biotite-hornblende diorite and quartz diorite with minor amphibolite and pyroxenite. Regional foliation of the gneisses strikes northwest and dips 20 to 50 degrees southwest.

The majority (about 65%) of the 261 mineral localities and deposits recorded in the Grand Forks map area occur in the Greenwood mining camp. This is a relatively small area that preserves wide geologic and metallogenic diversity. Concentrations of precious metals and copper, lead and zinc are found in accreted Paleozoic and early Mesozoic arc, back arc and oceanic terranes. The **Lexington** (082ESE041) - Lone Star (USA) copper-gold porphyry system, rooted in Proterozoic cratonic basement rocks, was emplaced in the early Jurassic subsequent to the accretion of the Knob Hill and Attwood groups. These groups are part of the Slide Mountain ophiolitic terrane. Reactivation of suture zones resulted in silver-lead-zinc mineralization such as those found at the **No. 7**

(082ESE043), **Skomac** (082ESE045) and **Skylark** (082ESE011) mines. These and the copper-gold skarn deposits, such as the **Phoenix** (082ESE020), **Greyhound** (082ESE050), **Mother Lode** (082ESE034), **Oro Denoro** (082ESE063) and **Eholt** (082ESE239) deposits, associated with the Brooklyn arc rocks, are the focus of traditional and ongoing exploration. New exploration in the camp is centred on silicified limestone deposits with bulk tonnage gold potential (the Carlin-type **PAC** prospect (082ESE194)), stratabound massive sulphides (the **Croesus** property (082ESE123)), and epithermal gold/silver related to Tertiary faulting (the **Tam O'Shanter** prospect (082ESE130)). For more details of this area see the ***Metallogeny of the Greenwood Mining Camp*** article.

Lode mineralization was first recorded near Greenwood in 1884 and major deposits of copper and gold have been mined here since the turn of the century. Most of the mineral production from the Greenwood mining camp is from copper-bearing skarn deposits and, to a lesser extent, polymetallic quartz veins and, less commonly, copper-gold porphyry deposits. Production from the principal mines in the Greenwood area resulted in 32,044,173 tonnes of ore, yielding 38,278 kilograms of gold, 183,102 kilograms of silver, 270,945 tonnes of copper, 966 tonnes of lead, and 329 tonnes of zinc.

The Westkettle batholith, which ranges in composition from granodiorite to quartz diorite, lies in the northwest part of the map area, east of the Beaverdell mining camp (082ESW). Based on correlations with the Nelson intrusions, a Jurassic (ca. 150 Ma) age is reasonable for the Westkettle batholith. These rocks intrude stratified rocks of the Anarchist Group, which consists of metamorphosed andesitic tuffs and lavas, hornfels and minor limestone. The stratified and igneous rocks are host to gold-silver-copper quartz veins. This area has been explored intermittently since the late 1800's. Minor production occurred on the **Mogul** (082ESE068) and **Barnato** (082ESE109) in the 1930's and 1960's.

In the eastern part of the map area, the Burnt Basin mining camp, 10 kilometres northeast of Christina Lake is underlain by Mount Roberts bedded rocks and Nelson and Coryell igneous intrusions. Intermittent activity since 1965 was focused on Ag-Pb-Zn sulphide occurrences on several claims. Other types of mineralization include auriferous quartz veins, magnetite/sulphide replacements, and sulphide disseminations. Production in the 1970's occurred mainly on the **Eva Bell** (082ESE169) and **Halifax** (082ESE099).

The southeast part of map area is host to the **Castle Mountain Nickel** deposit (082ESE091), which is a wedge-shaped ultramafic complex comprised of serpentinized dunite of the Permian-Carboniferous Anarchist Group. Rossland Group greenstone breccias, tuffs, flows and metasedimentary rocks surround the ultramafic body to the west, north and northeast, while foliated monzonites of the Jurassic Nelson Intrusions outcrop to the east and southeast. The contacts with these surrounding rocks are fault-bounded and commonly quartz-talc-carbonate altered. Nickeliferous magnetite and nickel sulphide minerals consisting of pentlandite, millerite and heazlewoodite are more or less uniformly distributed and disseminated throughout the ultramafic body. Chromite occurs as disseminated grains, stringers and massive lenses. Indicated reserves have been reported as 354,676,100 tonnes, averaging 0.2 per cent nickel.

Within the Grand Forks Gneiss, principal host rocks for uranium mineralization are quartz-rich pegmatites, which are interlayered with the biotite gneisses and schists. Uraninite is associated with biotite clots in the pegmatite and uranophane and autunite occur along fractures and joints in the pegmatite and biotite gneiss. Distribution of the uranium is erratic within the pegmatites, which seldom exceed 2.0 metres in thickness. The **SD** showings (082ESE142-145, 195), 10 kilometres northeast of Grand Forks are examples of these occurrences.

Limestone and dolomite deposits occur in several of the map units. Carbonate beds up to 90 metres thick occur in the Anarchist Group; deposits include **Thimble Mountain** (082ESE237) and **Boundary Falls** (082ESE226, 227). Brooklyn Group deposits include the **Deadwood Creek**, **Eholt**, **Hardy Creek**, **Marguerite**, **Oro Denoro** and **Midway** deposits (82ESE228, 229, 230, 231, 232 and 235, respectively). The **Rock Creek** deposit (082ESE200) occurs in the Knob Hill Group. The Carboniferous to Permian Mount Roberts Formation contains the **Fife** (082ESE238) near Christina Lake and the **Broadwater** (082ESE211) east of Lower Arrow Lake. The **Grand Forks** (082ESE036) dolomite deposit is hosted in the Grand Forks Gneiss.

Dimension stone prospects and quarries within the map area include the **Gabe** (082ESE214), a pink quartz syenite of the Okanagan Batholith; the **San Pedro** (082ESE240), gabbro of a Nelson plutonic pendant in a Coryell

pluton.; the **Coryell** (082ESE213), black granite (coarse grained augite-biotite-hornblende monzonite) of the Coryell batholith; and the **Grand Forks Quartzite** (082ESE236), 3 layers of quartzite within the Grand Forks Gneiss.

The **Rock Candy** (082ESE070) fluorspar property, located north of Kennedy Creek, was in operation intermittently between 1918 and 1942, during which about 56,000 tonnes of ore was mined. Fluorite veins occur in Penticton Group andesites, adjacent to Coryell syenite.

At the **Picture Rock** quarry (082ESE242), 4.5 kilometres northwest of Midway, ornamental chalcedony has been obtained for lapidary purposes (clock faces and ornaments). Narrow epithermal chalcedonic veins cut altered serpentinite (listwanite) and feldspar porphyry dikes. Typically the veins are delicately banded in white, grey, light blue and blue-green layers.

SELECTED REGIONAL REFERENCES (082ESE - GRAND FORKS)

Basque, Garnet (1992): Ghost Towns & Mining Camps of the Boundary Country; *Sunfire Publications Limited*, 152 pages.

Brock, R.W. (1901): The Boundary Creek District, British Columbia; *Geological Survey of Canada*, Summary Report 1901; pages 51A-67A.

Brock, R.W. (1903): Preliminary Report on the Boundary Creek District, British Columbia; *Geological Survey of Canada*, Summary Report 1902; pages 92A-138A.

Brock, R.W. (1905): Geological and Topographical map of Boundary Creek Mining District, B.C.; *Geological Survey of Canada*, Map 828, scale 1:63,360.

Brock, R.W. (1905): Topographical map of Boundary Creek Mining District (economic minerals, and glacial striae); *Geological Survey of Canada*, Map 834, scale 1:63,360.

Church, B.N. (1980): Preliminary Geological Map of the Penticton Tertiary Outlier; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Preliminary Map 35, scale 1:50,000.

Church, B.N. (1985): Geology of the Mount Attwood - Phoenix Area, Greenwood; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1984, Paper 1985-2, pages 17-22.

Church, B.N. (1985): Geology and Mineralization in the Mount Attwood - Phoenix Area, Greenwood, B.C.; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Preliminary Map 59, scale 1:25,000, with accompanying notes, 35 pages.

Church, B.N. (1986): Geological Setting and Mineralization in the Mount Attwood - Phoenix Area of the Greenwood Mining Camp; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Paper 1986-2, 65 pages; Map scale 1:25,000.

Church, B.N. (1992): The Lexington Porphyry, Greenwood Mining Camp, South-Central British Columbia; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1991, Paper 1992-1, pages 295-297.

Daly, R.A. (1912): Geology of the North American Cordillera at the Forty-ninth Parallel, *Geological Survey of Canada*, Memoir 38, pages 377-423; Maps 82A, 83A, scale 1:63,360.

Fyles, J.T. (1989): Geology of the Pre-Tertiary Rocks in the Rock Creek - Greenwood Area (82E/2); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 11-18.

Fyles, J.T. (1990): Geology of the Greenwood - Grand Forks Area, British Columbia NTS 82E/1,2; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1990-25, 37 pages; Map scale 1:50,000.

Höy, T., Church, B.N., Legun, A., Gibson, G., Glover. K., Grant, B., Wheeler, J.O. and Dunne, K.P. (1994): Geology of the Kootenay River Map Area; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1994-8; diskettes, map and text.

LeRoy, O.E. (1912): The Geology and Ore Deposits of Phoenix, Boundary District, British Columbia; *Geological Survey of Canada*, Memoir 21, 110 pages; Map 16A, scale 1:4800.

Little, H.W. (1957): Kettle River (East Half) British Columbia; *Geological Survey of Canada*, Map 6-1957, scale 1:253,440.

Little, H.W. (1983): Geology of the Greenwood Map-Area, British Columbia; *Geological Survey of Canada*, Paper 79-29, 37 pages; Map 1500A, scale 1:50,000 (082E02).

Mathews, W.H. (1986): Physiographic Map of the Canadian Cordillera; *Geological Survey of Canada*, Map 1701A, scale 1:5,000,000.

Matysek, P.F., Jackaman, W., Sibbick, S.J., Gravel, J. (1991): Regional Geochemical Survey Release, Penticton (NTS 82E); *B.C. Ministry of Energy, Mines and Petroleum Resources*, RGS 29; 1545 sites.

McNaughton, D.A. (1945): Greenwood - Phoenix Area, British Columbia; *Geological Survey of Canada*, Paper 45-20, 23 pages; Map 45-20A, scale 1:9600.

MEMPR (1973): Penticton 082E; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Aeromagnetic Map 7686G, scale 1:250,000.

MEMPR (1932): Grand Forks, Greenwood and Trail Creek; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Mineral Reference Map 6 (Showing Surveyed Claims), scale 1:63,360.

MEMPR (1973): Grand Forks 082E01; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Aeromagnetic Map 8487G, scale 1:63,360.

MEMPR (1973): Greenwood 082E02; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Aeromagnetic Map 8497G, scale 1:63,360.

MEMPR (1973): Almond Mountain 082E07; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Aeromagnetic Map 8498G, scale 1:63,360.

MEMPR (1973): Deer Park 082E08; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Aeromagnetic Map 8448G, scale 1:63,360.

Monger, J.W.H. (1968): Early Tertiary Stratified Rocks, Greenwood Map-Area, (82E/2) British Columbia; *Geological Survey of Canada*, Paper 67-42, 39 pages; Map 10-1967, scale 1:63,360.

Okulitch, A.V. (1978): Thompson-Shuswap-Okanagan, British Columbia; *Geological Survey of Canada*, Open File 637, scale 1:250,000.

Peatfield, G.R. (1978): Geologic History and Metallogeny of the Boundary District, Southern British Columbia and Northern Washington; unpublished Ph.D. Thesis, *Queen's University*, 250 pages and appendices.

Preto, V.A. (1970): Structure and Petrology of the Grand Forks Group, British Columbia; *Geological Survey of Canada*, Paper 69-22, 80 pages.

Read, P.B. (1991): Metamorphic Map of the Canadian Cordillera; *Geological Survey of Canada*, Map 1714A, scale 1:2,000,000.

Seraphim, R.H. (1956): Geology and Copper Deposits of Boundary District, British Columbia; *Canadian Institute of Mining and Metallurgy*, Bulletin, Volume 49, pages 684-694.

Tempelman-Kuit, D.J. (1989): Geological Map with Mineral Occurrences, Fossil Localities, Radiometric Ages and Gravity Field for Penticton Map area (NTS 82/E) Southern British Columbia; *Geological Survey of Canada*, Open File 1969, scale 1:250,000.

Tempelman-Kuit, D.J. (1989): Geology, Penticton, British Columbia; *Geological Survey of Canada*, Map 1736A, scale 1:250,000 (082E).

Wheeler, J.O. and McFeely, P. (comp.) (1991): Tectonic Assemblage Map of the Canadian Cordillera and adjacent parts of the United States of America; *Geological Survey of Canada*, Map 1712A, scale 1:2,000,000.

Wheeler, J.O., et. al. (comp.) (1991): Terrane Map of the Canadian Cordillera; *Geological Survey of Canada*, Map 1713A, scale 1:2,000,000.