



MINFILE Detail Report  
BC Geological Survey  
Ministry of Energy, Mines and Petroleum Resources

### Location/Identification

<b>MINFILE Number:</b>	094E 094	<b>National Mineral Inventory Number:</b>	094E2 Cu8
<b>Name(s):</b>	<b>KEMESS SOUTH</b> RON, SOUTH KEMESS		
<b>Status:</b>	Past Producer	<b>Mining Division:</b>	Omineca
<b>Mining Method</b>	Open Pit	<b>Electoral District:</b>	Peace River North
<b>Regions:</b>	British Columbia	<b>Resource District:</b>	Mackenzie Natural Resource District
<b>BCGS Map:</b>	094E007		
<b>NTS Map:</b>	094E02W	<b>UTM Zone:</b>	09 (NAD 83)
<b>Latitude:</b>	57 00 21 N	<b>Northing:</b>	6320284
<b>Longitude:</b>	126 45 03 W	<b>Easting:</b>	636596
<b>Elevation:</b>	1277 metres		
<b>Location Accuracy:</b>	Within 500M		
<b>Comments:</b>	Kemess South deposit, located 750 metres west of Kemess Creek and 4 kilometres south of Duncan Lake, approximately 265 kilometres north of the community of Smithers. The Omineca Mine Road passes 5 kilometres west of the property. See also Kemess North (094E 021).		

### Mineral Occurrence

<b>Commodities:</b>	Copper, Gold, Molybdenum, Silver		
<b>Minerals</b>	<b>Significant:</b>	Chalcopyrite, Chalcocite, Copper, Molybdenite	
	<b>Significant Comments:</b>	Molybdenite and magnetite are minor. Supergene minerals include chalcocite, native copper, cuprite and malachite (Bulletin 86).	
	<b>Associated:</b>	Quartz, Calcite, Pyrite, Magnetite	
	<b>Alteration:</b>	Sericite, Clay, Quartz, Calcite, Carbonate, Chlorite, Hematite, Gypsum, Cuprite, Malachite, Zeolite	
	<b>Alteration Type:</b>	Sericitic, Propylitic, Carbonate, Oxidation	
	<b>Mineralization Age:</b>	Unknown	
<b>Isotopic Age:</b>	199.6 +/- .6	<b>Dating Method:</b>	Uranium/Lead
		<b>Material Dated:</b>	Zircon
<b>Deposit</b>	<b>Character:</b>	Disseminated, Stockwork, Vein	
	<b>Classification:</b>	Porphyry	
	<b>Type:</b>	L03: Alkalic porphyry Cu-Au	
	<b>Dimension:</b>	1700x650x290 metres	
	<b>Comments:</b>	Zone of porphyry mineralization. Date from mineralized dacite porphyry.	

### Host Rock

<b>Dominant Host Rock:</b>	Plutonic		
<b>Stratigraphic Age</b>	<b>Group</b>	<b>Formation</b>	<b>Igneous/Metamorphic/Other</b>
Upper Triassic	Stuhini	-----	-----
Lower Jurassic	-----	-----	Maple Leaf Pluton
<b>Isotopic Age</b>	<b>Dating Method</b>	<b>Material Dated</b>	
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199.6 +/- .6 Ma	Uranium/Lead	Zircon	
<b>Lithology:</b>	Quartz Monzonite, Basalt Andesite Flow, Andesite, Basalt, Granodiorite, Quartz Diorite, Syenite, Chert, Cherty Tuff, Argillite		
<b>Comments:</b>	Personal communication - Friedman to Diakow in Fieldwork 1997, pages 8a-12.		

### Geological Setting

<b>Tectonic Belt:</b>	Intermontane	<b>Physiographic Area:</b>	Omineca Mountains
<b>Terrane:</b>	Stikine, Plutonic Rocks		

Grade: Greenschist, Zeolite

### Inventory

Ore Zone: KEMESS SOUTH

Year: 2010

Category: Proven

Report On: Y

Quantity: 3,495,000 tonnes

NI 43-101: Y

Commodity	Grade
Gold	0.24 grams per tonne
Copper	0.12 per cent

Comments: As of December 31, 2010.

Reference: WWW <http://www.northgateminerals.com>

### Summary Production

		Metric	Imperial
Mined:		473,376,688 tonnes	521,808,477 tons
Milled:		228,732,478 tonnes	252,134,397 tons
Recovery	Gold	91,903,400 grams	2,954,763 ounces
	Silver	4,871,000 grams	156,606 ounces
	Copper	355,450,336 kilograms	783,633,852 pounds

### Capsule Geology

The Kemess South deposit is located 750 metres west of Kemess Creek and 4 kilometres south of Duncan Lake, approximately 265 kilometres north of the community of Smithers. The Omineca Mine Road passes 5 kilometres west of the property. See also Kemess North (094E 021).

Discovered in 1983, extensive diamond drilling up until 1991 outlined the Kemess South deposit. The deposit is not exposed at surface and this blind discovery was made by drill testing geochemical and geophysical anomalies. Prospectors were originally drawn to the region because of the prominent, rust-coloured ridges that occur immediately to the north, and in part comprise the Kemess North deposit (094E 021). The Kemess South deposit is hosted by the Early Jurassic Maple Leaf intrusion, a gently inclined sheet of quartz monzodiorite. The orebody measures 1700 metres long by 650 metres wide and ranges from 100 metres to over 290 metres thick. A blanket of copper-enriched supergene mineralization containing native copper, overlies hypogene ore and comprises 20 per cent of the deposit.

The Kemess property is located in the southern part of the Toodoggone mining district in north-central British Columbia. The Toodoggone district lies within the eastern margin of the Intermontane Belt and is underlain by a northwesterly trending belt of Paleozoic to Tertiary sediments, volcanics and intrusions covering an area of 90 by 25 kilometres. The basement rocks are Proterozoic metasedimentary equivalents of the Hadrynian Ingenika Group. These rocks are unconformably overlain by volcanic and sedimentary units of the Permian Asitka Group which are in turn overlain by Upper Triassic basaltic to andesitic flows, volcanoclastics and minor limestone of the Stuhini Group. Volcanoclastic rocks of the Lower Jurassic Hazelton Group and rhyolitic to dacitic flows, intrusions and volcanoclastics of the Lower Jurassic Toodoggone Formation (Hazelton Group) overlie the Stuhini Group. Further to the west, non-marine sediments of the Cretaceous Sustut Group overlie the volcanic strata and form the western margin of the district.

The Early Jurassic Black Lake Suite of quartz monzonitic to granodioritic composition have intruded the older strata in the central and eastern parts of the region, and form the eastern margin of the Toodoggone district. Within the district, syenomonzonitic and quartz feldspar porphyritic dikes may be feeders to the Toodoggone Formation.

Bedrock is poorly exposed in the Kemess South occurrence area. Drilling and mapping show the geology to consist of Stuhini Group volcanics and sediments which have been intruded by Lower-Middle Jurassic quartz monzonite. Other intrusive compositions include granodiorite, quartz diorite and some syenite. Most of the volcanic rocks intersected in drilling are presumed to have been flows, with compositions in the basalt to andesite range. Their fine grain size and a strong alteration overprint obscure their primary mineralogy. A few crystal tuff units and lapillistones exist. They are not volumetrically significant and in most instances are associated with sedimentary units. Sedimentary rocks intersected in drillholes include chert, cherty tuff, argillite and graphitic argillite. The sediments are interlayered with the volcanic flows.

Most of the deformation at Kemess South has taken the form of brittle fracturing; on a large scale as faulting and a smaller scale as jointing. The myriad fractures, faults and breccia zones are difficult to correlate from drillhole to drillhole. The one exception to this, easily correlated because of the

lithologic markers, is a fault that is consistently present at the base of the quartz monzonite. Several generations of veins and stockworks, plus many later unhealed joints and fractures, evidence a long history of fracturing.

With the possible exception of cherts and argillites in the Stuhini strata, all of the rocks have been altered. There is a complex overprinting of alteration assemblages and are listed in approximate time sequence starting with the earliest: 1) sericitization of plagioclase - most of the plagioclase in the quartz monzonite has been altered to an aggregate of fine-grained sericite and clays; 2) quartz veinlets - quartz is fracture filling, forming veinlets and veins in a stockwork that make up anywhere from 5-30 per cent of the rock over tens of metres and as much as 70 per cent of the rock over a few metres. The most common veinlets are a few millimetres to a few centimetres thick; 3) chlorite - much of the fault gouge noted throughout drill core has a chloritic component; 4) calcite veining - calcite veinlets are widespread throughout, cutting many other alteration assemblages. Quartz-calcite veins are common, but most are quartz veins, fractured and invaded by calcite. Other minerals sometimes associated with calcite are chlorite and hematite; 5) carbonate veining - carbonate veining is used here to describe veins containing a carbonate mineral that is not calcite. In most cases it is probably iron carbonate. Like the calcite veins, carbonate veins are late; 6) gypsum - late veinlets of gypsum, though not volumetrically important, are present throughout the lithologic assemblage; and 7) zeolites - some of the late veinlets contain what are probably zeolite minerals. Like gypsum, they are widespread but not volumetrically important.

Mineralization at Kemess South is hosted within a relatively flat-lying body of quartz monzonite and extends a short distance into Stuhini volcanics and sediments in the footwall. A veneer of overburden from 3-24 metres thick and averaging 10 metres covers the quartz monzonite. The sulphide assemblage consists of pyrite and chalcopyrite disseminated in both quartz veins and the altered host quartz monzonite. Molybdenite and magnetite are minor. Supergene minerals include chalcocite, native copper, cuprite and malachite (Bulletin 86). The zone of porphyry mineralization is blanket shaped, measuring 1700 metres in an east-west direction, 650 metres north-south, and ranging in vertical thickness from 100 to greater than 290 metres. The zone lies very near surface in the eastern half of the deposit while its depth increases toward the west, lying up to 182 metres below the surface. The north, south and eastern limits of the deposit have been delineated, while the zone remains open to the west (Northern Miner - January 20, 1992).

Later work suggests that the rhyolites and cherts are part of the Pennsylvanian to Permian Asitka Group and that the augite and plagioclase phyric basalts are part of the Upper Triassic Stuhini Group. These have been intruded by the Maple Leaf pluton, and brought to surface to be affected with by supergene enrichment. Later dacitic ash flow tuffs, lithic tuffs, and epiclastic rocks of the Toodoggone Formation of the lower Hazelton Group overlie the deposit.

The deposit itself is hosted, in part, in the rhyolite and mineralization consists of pyrite, magnetite, chalcopyrite and bornite with minor amounts of molybdenite and traces of gold. They occur on fractures and in veins and interstitial to feldspars. The most important alteration is sericite which may form up to 25 per cent of the rock. A less abundant alteration is a pink potash feldspar alteration which forms selvages on quartz and/or sulphide veins and stockworks. Below this type of alteration, near the lower edge of the pluton, a hematite, clay, carbonate, and silica-rich zone is found. The supergene zone, on the other hand, is above these alteration zones and it is increasingly developed as small pinprick flakes of native copper that become leaf-like and eventually coalesce to form sheets of native copper at the top of the zone, in red oxidized clay-rich rock. At the top is the "leach cap" which is enriched in gold and contains very little copper (Fieldwork 1998, pages 103-114).

Mineable "reserves" are estimated at 45.5 million tonnes grading 0.20 per cent copper and 0.75 gram per tonne gold (supergene) and 155 million tonnes grading 0.23 per cent copper and 0.59 gram per tonne gold (hypogene) for an overall reserve of 200.4 million tonnes grading 0.22 per cent copper, 0.63 gram per tonne gold and 0.008 per cent molybdenum. Mill throughput is proposed at 45,000 tonnes per day, providing a mine life in excess of 16 years (Information Circular 1996-1, page 11; 1997-1, page 13).

A project approval certificate was awarded in April 1996, with production scheduled to commence in April 1998. Construction of an airstrip and site facilities commenced in mid-1996. Kemess South is owned and operated by Kemess Mines Inc., a wholly owned subsidiary of Royal Oak Mines Inc.

From 1966 to 1971, Kennco Exploration Ltd. conducted work in the Kemess area. They collected regional stream and soil samples, staked 100 two-post mineral claims, completed soil, silt and rock geochemical surveys, conducted geological mapping and completed 232 metres of X-ray core drilling in eight holes. From 1975 to 1976, Getty Mines and Shell Oil Ltd. operated the property that they optioned property from Kennco. They completed geological mapping, orthomapping, geochemical surveying and completed 2065 metres of diamond drilling in 13 holes (75-18 to 76-30). They dropped the option in 1977.

From 1986 to 1992, El Condor Resources Ltd. held the Kemess area. In 1986, El Condor optioned the property from Kennco and commenced sustained exploration that resulted in the discovery at Kemess South. Over a six-year period at Kemess North (094E 021), El Condor collected 1025 rock samples and 5402 geochemical samples, completed 76.85 kilometres of ground electromagnetics (EM), 14.1 kilometres of ground magnetic surveying, 161.4 kilometres of induced polarization (IP), and drilled 14,328 metres of core in 69 holes. Additional work included 167 kilometres of line cutting, 54.5 kilometres of roads, and 475 metres of cat trenching. An inferred resource of 157 million tonnes at 0.37 gram per tonne gold and 0.16 per cent copper resulted at Kemess North (as reported in Assessment Report 29848).

During the pre-production stripping phase of the project, which started in July of 1997, over 8,000,000 tonnes of overburden and waste were removed from the open pit. From the start of operations in mid-May to August 11, 1998, approximately 2,450,000 tonnes of hypogene ore at a grade

of 0.22 per cent copper and 0.55 gram per tonne gold has been mined. From May to the end of September, about 1.8 million tonnes of ore were processed, producing 1,191,300 grams of gold and 5,080,000 kilograms of copper. The average strip ratio for the project is estimated to be about 1.18 to 1 over the estimated 16-year life of the mine.

Production in 1998 totalled 7,482,000 tonnes yielding 9,690,000 kilograms of copper and 2,393,000 grams of gold. In October 1999, Northgate Exploration Ltd. agreed to take over the Kemess mine. Resources estimated by Royal Oak as of January 1, 1999 were 192,918,000 tonnes, grading 0.22 per cent copper and 0.63 gram per tonne gold (Information Circular 2000-1, page 6). Four different ore types (leached cap supergene, transitional and hypogene) are mined separately from a starter pit.

In 2000, Northgate Limited Exploration held the Kemess property. In 2000, 4104.45 metres of diamond drilling in 12 holes identified a new higher grade porphyry zone located east of El Condor's discovery. This work increased the inferred resource at Kemess North to 360 million tonnes at 0.299 gram per tonne gold and 0.154 per cent copper (as reported in Assessment Report 29848). Reserves at Kemess South as of December 31, 2000 were Proven 145,911,266 tonnes grading 0.653 gram per tonne gold, 0.235 gram per tonne copper and Measured 56,107,795 tonnes grading 0.39 gram per tonne gold and 0.161 gram per tonne copper (Northgate Exploration News Release, January 22, 2000).

In 2001, reserves at Kemess South as of December 31 were Proven 132,587,789 tonnes grading 0.704 gram per tonne gold and 0.233 per cent copper and Indicated 56,107,795 tonnes grading 0.39 gram per tonne gold and 0.161 per cent copper (Northgate website).

As of December 31, 2002 the Proven reserve is 109,360,244 tonnes grading 0.712 gram per tonne gold and 0.234 per cent copper. The Indicated resource is 47,949,103 tonnes grading 0.481 gram per tonne gold and 0.168 per cent copper (www.northgateexploration.ca, January 8, 2004).

In 2003, production of gold from the mine exceeded that of any other British Columbia gold-producing porphyry deposit. Existing reserves at the Kemess South deposit will provide mill feed until 2008. However, the life of the overall operation could be extended to 2019 if the advanced exploration stage Kemess North (092E 021) deposit is put into production.

In 2004, exploration and infill drilling on the margin of the pit resulted in the addition of 11.8 million tonnes of ore grade material being added to the reserve base of the Kemess South deposit. A total of 7307 metres of drilling were carried out.

In 2005, mill throughput averaged approximately 50,000 tonnes per day. Forecast metal production for the year was 8700 kilograms of gold, 33,100 tonnes of copper and 10,600 kilograms of silver making Kemess South British Columbia's single largest gold producer. Northgate Minerals submitted an Environmental Impact Assessment report on the Kemess North (094E 021) project to the joint British Columbia Environmental Assessment Office - Canadian Environmental Assessment Agency panel for review. The proven and probable reserve estimate for Kemess North is 414 million tonnes grading 0.16 per cent copper and 0.307 gram per tonne gold (Exploration and Mining in British Columbia 2005, page 44). Approval would extend the mine life of the Kemess operation to approximately 2020. The proposal includes utilizing Duncan Lake for permanent storage of 397 million tonnes of tailings and up to 325 million tonnes of waste rock.

In 2006, a late season infill drilling program was completed immediately east of the Kemess South pit in an attempt to add tonnage to the mine's reserve base and extend the life of the mine. The drilling confirmed continuity of mineralization and an economic evaluation to upgrade the resource was initiated.

In 2008, Northgate Minerals Corp. scaled its 2008 exploration program back drastically from 2007, when its focus had been in developing prospects related to the proposed Kemess North mine. The 2008 program was entirely related to possibly of extending the life of the Kemess South mine. Northgate Minerals Corp. completed an IP survey on a grid north of the tailings dam.

The 2009 Northgate program comprised geological mapping, geophysics and a planned 4000 metres of core drilling. Geophysical work included a low-level airborne magnetic survey and a 420 kilometre IP and gravity grid. Mining of the West pit was terminated approximately in August 2009 by failure of the Toodoggone epiclastic rocks at the west end of the pit. The epiclastic rocks are high in montmorillonite and decompose quickly to material having an angle of repose of only 8 degrees. Since then, waste rock and tailings were placed in the West pit. In the East pit, the North wall is also problematic. Graphitic sedimentary rocks of the Asitka Group dip south into the pit and, where undercut by mining, are prone to failure.

The Kemess South mine ceased production late in 2010. Stockpiled ore continued to be processed until March 2011, during which time 3.04 million tonnes of ore were processed to produce 2947 million kilograms copper and 410 kilograms gold from the old workings.

In 2011, Northgate Minerals Corp.'s Kemess mine ceased production and the permitting process for its nearby Kemess Underground mine project was underway. In October 2011, Aurico Gold Inc. acquired Northgate Minerals Corp. and, along with that, Northgate's Kemess mine and Kemess Underground project (formerly Kemess North, 094E 021).

From 1998 to 2010 inclusive, a total of 473,376,688 tonnes were mined and 228,732,478 tonnes were milled at the Kemess South deposit. From this a total of 91,903,400 grams of gold, 4,871,000 grams of silver and 355,450,336 kilograms of copper were recovered (www.northgateminerals.com).

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<b>Date Coded:</b>	1986/06/02	<b>Coded By:</b>	Allan Wilcox (AFW)	<b>Field Check:</b>	N
<b>Date Revised:</b>	2021/07/30	<b>Revised By:</b>	George Owsiacki (GO)	<b>Field Check:</b>	N