Kirkland Lake-Larder Lake Gold Mining Area

INTRODUCTION

The Kirkland Lake-Larder Lake mining area is near the centre of the Abitibi Greenstone Belt, famous for its rich mineral endowment. The town of Kirkland Lake is in Teck Township at latitude 48°09' north and longitude 80°03' west.

History

The Larder Lake area in 1906 was the scene of the first gold rush in northeastern Ontario. Prospectors fanning out from the 1903 silver discoveries of Cobalt, Ontario, found gold on the shore of Larder Lake, which became the Kerr Addison mine. The gold for the first five dollar gold piece minted in Canada from Canadian gold (issued in 1909) came from the Kerr Addison property. Also in 1906, gold was discovered at Swastika 5 km west of Kirkland Lake. In 1911, Bill Wright discovered gold at Kirkland Lake. In the early stages of development, results at the mines were disappointing and might have discouraged developers less resourceful than the pioneers. The first gold production in the Kirkland Lake area from the Tough-Oakes (Toburn) property was in 1913, from Teck-Hughes in 1917, Lake Shore in 1918, Kirkland Lake Gold in 1919, Wright-Hargreaves in 1921, Sylvanite in 1927, and Macassa in 1933. It was not until 1936 that sufficient tonnage of ore was indicated at the site of the original Larder Lake discovery, in what then became known as the Kerr Addison mine, now a past producer.

During the 1930's depression years, the Kirkland Lake-Larder Lake area, with 22 producing mines, was one of the most flourishing areas in Canada. After Word War II, rising costs of material and labour were not accompanied by an increased gold price. The resultant cost-price squeeze was compensated to some extent for some time by the Canadian government's Emergency Gold Mining Assistance. However, mining ceased at Toburn in 1953, Kirkland Minerals in 1960, Sylvanite in 1961, Lake Shore and Wright-Hargreaves in 1965 and Teck Hughes in 1968. At the Macassa mine, mining operations ceased in 1999, two years following rock bursts, which caused extensive damage to the No. 3 shaft below 1800 m. Foxpoint Resources Ltd. acquired five of the former seven Kirkland Lake gold producers and is recommencing mining operations. The reduction in gold mining activities in the sixties was partly offset by the Adams iron mine, which closed in 1990.

Current gold production is from Macassa and Lake Shore properties and further afield at two new gold mines, the Holt-McDermott and Holloway mines in Holloway Township, which commenced production in 1988 and 1996, respectively.

Production

Historical gold production from the Kirkland Lake - Larder Lake mining area is the second highest in Canada (following the Timmins area of Ontario), some mines having produced continuously for almost 50 years. By the end of 2001, the mines in the Kirkland Lake - Larder Lake area milled 105,960,533 tons of ore and produced 36,905,973 ounces of gold at a

recovered grade of 0.348 ounces gold per ton. In addition, 3,505,905 tons of tailings produced 212,440 ounces of gold at a recovered grade of 0.061 ounces gold per ton.

GENERAL GEOLOGY

All exposed bedrock in the Kirkland-Lake - Larder Lake area is Precambrian. Archean volcanic, sedimentary, and intrusive rocks contain the mineralization of economic interest. Near Kenogami Lake in the west, and Kerr Addison in the east, relatively flat-lying Proterozoic sedimentary rocks cover the older folded formations. Pleistocene deposits of sand, gravel, and clay mantle about 90 % of the bedrock.

Archean volcanic rocks with inter-bedded slate and chert are the oldest rocks (2.747 Ga to 2.705 Ga) and range from komatiite to mostly iron and magnesium-rich tholeiites at the stratigraphical base to calc-alkaline volcanic rocks at the stratigraphical top. These rocks contain long narrow bodies of diorite and gabbro as well as coarse-grained flows.

Timiskaming-type interbedded sedimentary and volcanic rocks, also Archean in age (2.680 Ga), unconformably, overlie the older volcanic rocks. They form a long, relatively narrow east-trending belt intruded by syenite (2.673 Ga).

Lamprophyre dikes are widespread and most of the "diabase" is of the "Matachewan" swarm of north-striking dikes (2.485 Ga).

Overlying all the above rocks with great unconformity are Proterozoic undeformed Huronian sediments of the Cobalt group intruded by Nipissing Diabase (2.200 Ga).

Jurassic age diamond-bearing kimberlite pipes are found east of Kirkland Lake and Matheson.

STRUCTURES

The two most prominent gold-bearing structures are the Larder Lake Deformation Zone and Kirkland Lake “main break”

Larder Lake Deformation Zone

The Larder Lake Deformation Zone is a carbonatized shear zone characterized in some places by the presence of quartz stockwork, and green mica. It is considered to be the western extension of the Malartic-Cadillac Deformation Zone, making it more than 160 km long. On surface and in drill-holes and underground workings, the Larder Lake Deformation Zone has been traced at intervals from east of Kerr Addison mine to west of Kenogami Lake. It is exposed about 2 km south of the gold mines of Kirkland Lake. The deformation zone is a south-dipping reverse fault, the south side of which seems to have moved upward and eastward relative to the north side.

Kirkland Lake "Main Break"

The Kirkland Lake "main break" is a fault zone branching northeastward from the Larder Lake Deformation Zone in the vicinity of Kenogami Lake. It passes through all the gold mines at Kirkland Lake, and has been identified to a depth of more than 2 km. Relative to the north side, its south side moved up 460 m almost vertically. The fault zone varies from a single plane to

multiple bifurcating planes. The widest ore bodies are where crossover faults and tension fractures between the planes are numerous. The North and South veins are along two faults branching from the "main break" in the centre of the Kirkland Lake gold mines. These faults are also reverse faults along which the south side moved up relative to the north side. The North vein fault branches from the footwall of the "main break" at Lake Shore and extends east through Wright Hargreaves and Sylvanite mines to the Toburn, where it dies out. The South vein fault branches from the hanging wall at Wright-Hargreaves and continues west through Lake Shore, Teck-Hughes, and Kirkland Lake Gold.

Post-ore Faults

Post-ore strike-faults and transverse faults offset some of the ore bodies. The largest post-ore fault, the Lake Shore transverse fault, extends from surface to the deepest workings. It dips steeply southeast, and its east side moved down 100 m and north 200 m relative to its west wide,

ORE OCCURRENCES AT KIRKLAND LAKE

The gold mines at Kirkland Lake occur in a single geological orebody 5 km long and more than 2.4 km deep. The longest stoping length of ore is at the 3,000-foot level (914 m), where 2000 m of ore were shared by Teck-Hughes, Lake Shore, and Wright-Hargreaves. All ore is in or near the Kirkland Lake "main break" and subsidiary faults.

In the Kirkland Lake area, gold exists in all types of rock, but 85 percent of the ore is in syenitic plugs and trachytic flows in the belt of Timiskaming-type sedimentary rocks. The centre of the Kirkland Lake gold mines (at Teck-Hughes) is occupied by an irregular pipe-like felsic syenite body the dimensions of which is 300 m by 500 m at surface. The syenite pipe plunges about 45° west through Kirkland Lake Gold into Macassa and Tegren. Augite syenite, older than the felsic syenite, partially envelops it. Syenite porphyry, which extends on surface from the augite syenite to the eastern mine (Toburn), also plunges west. The southern contacts of the augite syenite and syenite porphyry dip more gently than their steeply dipping northern contacts, so the widths of the augite syenite and syenite porphyry increase with depth.

Gold occurs in quartz veins, silicified zones, sulphides, and tellurides. The quartz veins are found in faults, brecciated areas, and other zones formerly under tension. Native gold exists in host rocks and earlier-formed vein minerals. Gold is also present in calaverite, $AuTe_2$, and petzite, $(Ag\ Au)_2\ Te$, and is associated with fine-grained pyrite, which constitutes about two percent of the ore. Other minerals in the ore veins are potash feldspar; albite; ankerite; barite; tourmaline; actinolite; apatite; seritcite; chorite; chalcopyrite; hematite; galena; sphalerite; molybdenite; graphite; and the tellurides altaite (PbTe), coloradoite (Hg Te), and melonite ($Ni_2\ Te_3$).

The ore zone at Kirkland Lake did not "bottom out", however, Lake Shore and Wright-Hargreaves are the deepest underground developments, being 2,492 m and 2,491 m deep, respectively. From the bottom levels to surface, multistage hoisting was necessary making some high-grade, gold-bearing material uneconomical to mine. In the 1980's, Macassa sunk a 2,202 m (7,225 foot) deep shaft to overcome this problem, however, a serious rock burst in 1997 resulted in closure of the mine.

ORE OCCURRENCES AT DOBIE

The Upper Canada mine is midway between Kirkland Lake and the Kerr Addison mine. As at Kirkland Lake, most of the ore at Upper Canada is along a subsidiary of the Larder Lake fault, in rocks of syenitic composition. Much of the Upper Canada ore is in quartz veins at the crests of folds, as was the ore at the Omega mine of the Larder Lake area. Most of the Upper Canada ore is in silicified zones along the contacts of syenite porphyry, tuff, trachyte, and red trachyte porphyry. Queenston Mining Inc. and previous joint venture partners discovered several gold-bearing zones, which require further exploration.

ORE OCCURRENCES AT LARDER LAKE

In the Larder Lake area, much of the ore was in quartz veins in carbonatized rocks, although most of Kerr Addison's production was from much less altered "flow ore" (lavas and tuffs) containing pyrite. Some of the syenite, tuffs, and talc-chlorite schists also contain ore. The main ore bodies in the Larder Lake area are associated with deformation that followed carbonatization of the Larder Lake fault. Only a fraction of the ore bodies were located within the original zone of intense shearing; the remainder was in adjacent hard competent rocks that failed under tension. Where no post-carbonate deformation exists, fracturing is weak and gold content low. In the Kerr Addison and Chesterville ore zone, which is a single geological unit, ore bodies on the south side appear to be localized in part within a pitching anticlinal fold. Ore bodies at the Omega mine lay near the apex of gentle swings in the strike of the mineralized zone.

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