Document generated on 12/26/2024 10:55 a.m.

Geoscience Canada

Gold Workshop, Yellowknife

W. A. Padgham

Volume 7, Number 2, June 1980

URI: https://id.erudit.org/iderudit/geocan7_2con02

See table of contents

Publisher(s)

The Geological Association of Canada

ISSN

0315-0941 (print)
1911-4850 (digital)

Explore this journal

Cite this article

Padgham, W. A. (1980). Gold Workshop, Yellowknife. *Geoscience Canada*, *7*(2), 80–82.

All rights reserved © The Geological Association of Canada, 1980

This document is protected by copyright law. Use of the services of Érudit (including reproduction) is subject to its terms and conditions, which can be viewed online.

https://apropos.erudit.org/en/users/policy-on-use/

This article is disseminated and preserved by Érudit.

Érudit is a non-profit inter-university consortium of the Université de Montréal, Université Laval, and the Université du Québec à Montréal. Its mission is to promote and disseminate research.

https://www.erudit.org/en/

became a forum for the discussion of a previously little recognized type of mineralization, and provided an opportunity for communication and exchange of ideas between specialists working on deposits in three continents.

Following the conference, a number of participants were led by Jensen and Pyke on tours of the gold deposits and general geology along the Larder Lake Break in Quebec and Ontario.

Acknowledgements
W. Peredery, O. R. Eckstrand, L. Jensen and M. E. Fleet assisted in the preparation of this report.

Reference

Arndt, N. T., and Brooks, C., 1980, Penrose Conference on Komatiites: *Geology*, in press.

MS received January 28, 1980

Gold Workshop, Yellowknife

W. A. Padgham
Department of Indian Affairs
and Northern Development
P.O. Box 1500,
Yellowknife, N.W.T. X1A 2R3

Increasing interest in gold, as the price neared $500 an ounce, was reflected by the 120 geologists who assembled in Yellowknife to participate in a gold workshop on December 3-5, 1979.

The meeting began Monday evening with an orientation session for those taking part in Tuesday and Wednesday morning trips to Giant Mines underground and open pit operations and to the Con Mine. Technical sessions were held on Tuesday and Wednesday afternoons with talks on the Economics of Gold on Tuesday evening. The workshop concluded on Wednesday evening with a memorable discourse on the early history of the Yellowknife Gold Camp by Dr. A. W. (Fred) Jolliffe, Professor Emeritus of Queens University. He amused, entertained and impressed some 250 people who attended a special meeting of the Charles Camsell Geological Society.

Jolliffe recounted the history of the first geological mapping of the north shore of Great Slave Lake in 1935. This work led directly to the discovery of gold in volcanics at Yellowknife when prospectors Vic Stevens, Don McLaren and Ed (Red Eye) McLellan accompanied geologist Novan Jennejohn, one of Jolliffe's assistants, on his last traverse of the year across part of the Kam basalts, considered favourable for minerals because they were intruded by a small granodiorite stock. Just north of the stock Jennejohn knocked a piece of quartz from an outcropping vein, found gold and with the aid of a federal government axe, staking began.

Referring to the most recent ideas on gold transport and deposition and the genesis of gold deposits in general as elaborated during the technical sessions, Jolliffe commented: "Clearly we gave them incorrect advice (to look for gold near a stock) but they found gold and that got the Yellowknife camp started."

Yellowknife Mines - Field Trips

Padgham (DIAND) began Monday night with an overview of the geology of the dominantly basaltic, epidote-amphibolite facies Yellowknife Volcanic Belt. The geology of Yellowknife mines was discussed by Dave McMurdo (Con) and Wilf Meyer (Giant).

Both mines are in complex quartz carbonate sericite shear zones. Usually there is more than one subparallel ore zone on any cross section. On the east side of West Bay Fault, ore zones at Giant have been mined (discontinously) over a length of nearly 6 kilometres but they have a limited vertical extent (500 m). Meyer noted the apparently folded nature of the Giant shear system within the 'unfolded', now near vertical, volcanic pile. Con orebodies on the west side of the Fault have much less horizontal extent than Giant's, about 1,500 m, but greater vertical extent. Ore has been found to below 1,600 m. No orebody in either mine extends the whole length or depth of the mined zones.

Meyer noted that though the Campbell shear zone was found by reconstructing offset on the late Proterozoic West Bay Fault, the orientation of the orebodies, their mineralogy and the differences in horizontal and vertical extent of ore zones makes direct correlation uncertain. He also contended that the sub-Jackson Lake unconformity is responsible for the marked thinning of the Kam Formation to the north and that the auriferous shear zones do not penetrate the unconformity into the overlying formations. Thus the unconformity has genetic significance for Yellowknife gold deposits. Not all who have worked in the area accepted this but most agreed that the shear zones appear to be spatially related to the volcanic/intrusive contact to the west.

The Con and Giant Mines have produced 5.9 million tons (3.5 m ounces) for an average grade of 0.6 ounce/ton and 10.2 million tons (6.34 m ounces) for an average grade of 0.62 ounce/ton respectively. This 9.84 million ounces represents 88% of the 11.2 million ounces of gold produced by all N.W.T. mines. Cut-off grades have been lowered with improved access and ore handling following the commission of the 6,000 foot deep Robertson shaft at the Con Mine and especially with open pit mining at the Giant Mines. Grades as low as 0.2 ounce/ton can be profitably mined from relatively small open pits which now provide approximately 30% of the Giant production.

Economics of Gold and of Gold Mining

Paul Kavanagh introduced the Tuesday

evening discussion with a talk on Precambrian gold deposits. He gave some interesting statistics. Estimated total world gold production has passed four billion ounces. One billion ounces was produced prior to Columbus landing in the Caribbean. Thus three billion ounces were produced in the last 500 years. The Archean has produced 400 million ounces, the Proterozoic 1.3 billion ounces (43% of the last 500 years production). Much of the Proterozoic gold has been recycled from the Archean by erosion and sedimentary concentration. The largest mine is the Muruntau Mine in Uzbekistan (U.S.S.R.). The largest mine on the Rand, the Elandsrand, has 56 million tons of reserves. It processes nearly two million tons per year to produce 1 million ounces.

Though gold has increased tremendously in price, so have production costs. Between 1973 and 1978, gold rose from $40 an ounce to around $160 an ounce, but production costs increased to $125 or more in most mines. Assuming $50/ton production costs for an underground operation of 1,000 tons per day, even at $600 an ounce, 0.15 ounce/ton is not likely to be economic for a small deposit.

Mike Fagan (Toronto Dominion Bank) underscored this 'bad news' side of the ledger. He noted that it was mainly increasing operating costs that reduced the number of Canadian gold mines from 120 in 1949 to 20 in 1979 and that the rise in gold price has had a concomitant increase in costs. He suggested that most gold mining ventures are too risky for banks to finance. Gold mining is capital intensive and until the bankers are convinced the price will stay up they will take a very hard look at 10 to 15 year paybacks on gold mines, and look elsewhere for investment opportunities. Banks deal in 'sure things' and they are reluctant to loan their depositors' funds for speculative endeavours. He also emphasized that the banks consider the quality of company management to be of major importance.

Barry Hancock (Cominco) reviewed the performance of many operating mines and pointed out that the Carlin mine netted $12.2 million in one year and that the Telfer gold mine in Western Australia paid off its capital in two years ($ A 30 million) and should be making $15.7 million a year at $350 gold.

Malcolm Slack (Noranda Mines Ltd.) presented the optimistic side of the gold mining equation. However, he noted that Campbell Red Lake, Canada's lowest cost producer pays more in tax than its $64 ounce (1978) cost. Estimates of cost increases are perhaps as reliable as estimates of future prices but the examples found in Table I were volunteered.

Table I

Mine	Cost $/Ounce 1978	1984
Campbell Red Lake	63.44	111
Giant Yellowknife Mines	161.28	285
Pamour Porcupine	184.90	325

The planned Carolin Mine in southern B.C. has three years of ore with mining proposed at 1,500 tons/day and a capital cost of 20 million dollars. At 83% recovery, operating profit per year is found in Table II.

Table II

Gold Price ($/oz)	Operating Profit/Year at $12.53/ton Operating Costs (in million $)
250	8.8
300	11.8
350	14.9
($700-800, January, 1980)	(?)

Slack also pointed out that world trade, which is 60% mineral products, did not collapse when fixed exchange rates did, but has continued to expand, suggesting that gold is working better as a monetary instrument that did currency. He also noted that the banks hold 50% of their reserve assets in gold and that in the future, oil will be exchanged for gold, not for currency. At today's gold price the Horne mine would have been a gold mine. As a commodity, gold is more attractive than ever and the chance of finding an economic gold deposit or making a gold deposit into a profitable mine are better in Canada than for any other metal.

Zinc is on the 'wrong end' of the energy crisis as cars become lighter, and copper is going to come mainly from the third world where large 'high grade' deposits are being developed - by industrial world money and technology. The Canadian Government has yet to realize that gold is a most important and potentially profitable mineral commodity at a time when oil has become so expensive.

Though the risks are great and the costs high, the profit may be commensurate and gold mining and gold exploration may be expected to expand rapidly in the next few years.

Gold - Metallogeny - Geology - Geochemistry

Bob Boyle (GSC) led the geological sessions by reviewing the geochemistry of gold and types of gold deposits in the Canadian Shield. Represented among producing mines are deposits in volcanic terrains (Yellowknife deposits); deposits in sedimentary terrains (Kirkland Lake); and stockwork deposits in complex environments. Gold bearing conglomerates and placer deposits have not been important in the Shield, but there is a possibility of pre-Pleistocene (buried Tertiary) placers. After many years of dominance by the magmatic-hydrothermal models, metamorphic secretion now appears to be the most favoured explanation of the genesis of Precambrian shear zone, quartz vein, and stockwork deposits. The most effective prospecting tools, after the gold pan, are stream or lake sediment, and soil/or till analyses. In deserts, geobotany has been effective. Humus analysis can be effective and laterites may contain two to ten times as much gold as normal soils. Laterites commonly develop on porphyry - Cu - Mo and -Au deposits.

Jim Crockett (McMaster University) discussed the Larder Lake break and the associated gold deposits in the light of recent neutron activation studies of gold in the Blake River and Misema River Group (Abitibi Volcanic Belt). He showed textural evidence that some rocks along the break are altered ultramafic and komatiitic flows and noted that spinifex bearing rocks from Munro Township contain 2.5 ppb gold. Crockett noted that we have no data on the extent to which gold can escape the ultramafic environment and he is sceptical of ultramafic rocks being the source of the gold deposited along the Larder Lake break.

Rolly Ridler (Newmont) concurred with most of Crockett's ideas and emphasized that the rocks along the break are highly altered and that 'chemical sediments' can form on the sea bottom by replacing practically anything.

Eric Hoffman (X-Ray Assay Labs) described gold analysis by neutron activation techniques. It is particularly effective for organic materials because no chemical treatment or ashing is required. The sample is compressed to form a briquette which is irrdiated and counted. Nuclear activation is particularly useful and effective in determining platinum and other platinoids. He suggested the best organic material to analyze for gold is two to three year old litter. Boyle commented that in areas of thick clays there are places where trees appear to be sampling bedrock through post-Pleistocene fracturing of the clays, and hence they may be a useful prospecting tool.

Bob Folinsbee (University of Alberta) described the vast but little known Kolyma placers in Siberia. The backbone of Russia's gold riches, these produce about 8 million ounces per year, which is nearly equal to the total Yukon and Alaskan placer production. He described a mile wide alluvial valley which was transected by sample trenched down to bedrock every kilometre along its 60 km length. A dredge was beginning to mine at one end of the valley and would ultimately mine the whole 60 km of valley bottom. Dredges such as this can produce 75,000 ounces of gold every two days.

N.W.T. Gold Mines

As an introduction to the Wednesday afternoon session, Padgham briefly described the varieties of deposit types of which the quartz-carbonate-sericite-chlorite schists formed in shear-zones in the Yellowknife volcanics are the richest and by far the most important. Walter Gibbins (DIAND) described the Contwoyto Lake and Cullaton Lake deposits in sedimentary amphibolite and iron formation respectively, noting that Cullaton Lake most resembles the Central Patricia deposit and Contwoyto Lake the Homestake.

Charlie Page (O'Brien Energy) provided details on the Cullaton Lake B-Zone, a stratabound ore body in magnetic iron formation in the dominantly clastic sediments of the Henik Lake Group. The iron formation consists of 250 to 400 feet of carbonate facies (ankerite and ferroan dolomite) and chert with 1 to 20 feet of iron-silicate facies containing ankerite and chert-ankerite nodules that indicate soft sediment deformation. Approximately 60% of the sulphide is pyrrhotite and the gold is closely associated with that mineral.

Rod Kerrich (University of Western Ontario) reviewed his work on the hydrothermal transport of gold. He asked why lode gold deposits are so strikingly abundant in Archean rocks, why carbonates are common with gold ores but rare with sulphide ores, what was the source of the hydrothermal solutions and how do they differ from those that deposited base metals. In seeking answers he noted that we cannot appeal to high gold levels in ultramafic rocks or Archean rocks in general. He pointed out that rare and immobile elements are concentrated in gold lodes relative to base metal deposits. Stable isotope studies indicate that rocks within 10 km of the surface interact with surface waters and can tell us something about the origin, temperature and volume of the fluids that passed through the system. Thus (most?) massive base metal deposits are deposited in or from sea water, the Butte type deposits come from a mixture of sea water and terrestrial waters, and the Western States type precious metal deposits from terrestrial waters. Stable isotopes studies of Archean cherts suggest Archean oceans were hot, possibly 80 to 90°C at 3.8 Ga dropping to 70 to 80°C around 2.6 Ga. Under these high temperatures, rare and immobile elements are separated from mobile and common elements. REE patterns are different because of complexing with CO_2 and Europium anomalies indicate generally reducing conditions in the Archean (seas?). Hydrogen, from water dissociation at high temperature, deposits iron.

The hydrothermal solutions that formed Archean gold deposits of the Yellowknife type were of metamorphic origin derived by outgassing at temperatures of 350 to 400°C. These solutions contained hydrogen and abundant CO_2 but low gold concentrations (1/20 billionth of a gram/liter). A fluid volume of 90 cubic miles would be required to form the Yellowknife deposits out of a source volume of 600 cubic miles. Anomalously high fluid pressures, described in detail by Allison (see below), is reflected in the banded veins. The gold does not come from the quartz porphyry stocks!

Ian Allison (University of Strathclyde) described the structure and evolution of the Yellowknife gold bearing shear zones. They formed at a crustal level which permitted brittle fracture and ductile deformation to take place alternately. Deformation continued for some time, at constant volume. Increased fluid pressure moved stress towards the envelope of failure and hydraulic facturing followed a period of ductile deformation. Openings that formed and subsequently filled with vein material during the brittle phase are bent during the ductile phase. The shear zones increased slightly in volume and are composed of a very non-isotopic rock. Shear zones in the Western Granodiorite are more or less identical to those in the greenstone belt, suggesting that the gold deposits formed after the granodiorite intrusion was emplaced. Thus the granodiorite is worth prospecting.

Del Myers (Cominco) discussed his geochemical studies of the Con Mine noting that Ag, Pb, and As could be used as 'pathfinders' of gold mineralization, but Au itself is easier and cheaper to use. The north edge of the Campbell 101 ore zone was found to be anomalously rich in Sb and this may mark a channelway for solutions which formed the Campbell 103 zone which lies above and to the north. He concluded that his geochemical data suggest the Yellowknife gold deposits were formed by prograde metamorphism of the base of the volcanic pile, or the underlying basement. This process liberated the gold and vast amounts of solution rich in H_2O and CO_2.

During the Geoscience Forum that followed the Gold Workshop, Herb Helmstaedt (Queens University) described DIAND detailed mapping of the southern end of the Yellowknife volcanic belt. This work suggests deformation becomes more ductile towards the contact with the Western Granodiorite complex and thus there may be a zone of brittle-ductile fracture related spatially to the contact, which is more favourable for gold deposits.

Roger Morton (University of Alberta) has consented to be the editor of a volume to publish the results of this workshop.

The Workshop was financially assisted by DIAND, the Robertson Trust Fund (GAC), the Charles Camsell Geological Society, the N.W.T. Chamber of Mines and Pacific Western Airlines.

MS received February 8, 1980

Geological Association of Canada
Association Géologique du Canada

Western and Arctic Canadian Biostratigraphy

Percival Sydney Warren Memorial Volume

Edited by C. R. Stelck and B. D. E. Chatterton
Geological Association of Canada Special Paper 18

This book, which includes 16 papers from a symposium of the same name, contains papers of biostratigraphic interest ranging in age from the Ordovician through to the Tertiary.

ISBN 0-919216-12-9

Order from Geological Association of Canada,
Business and Economic Service Ltd
111 Peter Street, Suite 509 Toronto Ontario M5V 2H1

GAC Members $18.50, Non-Members $22.00
(Postage and handling included)