I have given thee the gold countries;
given thee what is in them of electrum,
lapis lazuli, and malachite.
–An epistle to Seti I from the Sun God
as given in the inscription in the
Temple at Edfu, Egypt, circa 1300 B.C.

Chapter I. Introduction

Research on the geochemistry of gold was begun by the writer some 25 years ago and has continued at intermittent intervals in the field and laboratory since that time. The work is now essentially complete, and it was thought that increasing world interest in the metal merited a report at this time. This volume is meant as a companion to that on silver (Boyle, 1968*b*) and should be read in conjunction with it.

Historical notes on gold

Of all elements gold has been the most esteemed by man since the earliest times. The desire for gold has markedly influenced his history and was a deciding factor in the development of chemistry. The cry 'gold' has lured men across oceans and continents, over the highest mountain peaks, into the Arctic tundras, into scorching deserts and through impenetrable jungles. Its gleam prompted the expeditions and conquests of Jason of Thessaly, Cyrus and Darius of Persia, Alexander of Greece, Caesar of Rome, Columbus of Genoa, Cortez and Pizzarro of Spain, Raleigh of England and many others down through history. Gold, according to Pliny the Elder (*Historia naturalis,* 79 A.D.), is the first of man's follies, silver the second. To make gold from baser metals was a major preoccupation of the alchemists as was also their ceaseless efforts to discover the elixir of life and the fountain of youth. In fact, the alchemists considered that they had indeed discovered the fountain of youth in the potable gold made by solution of the metal in aqua regia followed by treatment with ethereal oils. Roger Bacon certainly thought so for in urging the elixir *"aurum potable, oleum auri, quinta essentia auri"* on Pope Nicholas IV he related.

> An old man, when ploughing a field in Sicily, one day found some of the yellow potable gold in a golden phial, and, supposing it to be dew, drank up the liquor. He was thereupon transformed into a hale, robust, and accomplished youth. The youth was thereafter received into the service of the Sicilian king, where he served some eighty years.

A thousand and more years of alchemy and innumerable experiments to make gold by concocting mixtures and potions of every conceivable type gave us the basis of modern chemistry. We can truly conclude with Francis Bacon.

> Surely to alchemy this right is due, that it may be compared to the husbandman whereof Aesop makes the fable; that, when he died, told his sons that he had left unto them gold buried in his vineyard; and they digged all over the ground, and gold they found none; but by reason of their stirring and digging the mould about the roots of their vines, they had a great vintage the year following: so assuredly the search and stir to make gold hath brought to light a great number of good and fruitful inventions and experiments.

Cadmus, the Phoenician, is said by some early writers to have discovered gold, but this is surely legend. Others say that Thoas first found it in the Pangaeus Mountains in Thrace. The *Chronicum Alexandrinum* ascribes its discovery to Mercury, the son of Jupiter, or to Pisus, king of Italy, who quitting his own country went into Egypt. In actual fact the discovery of the element we call gold is lost in antiquity. Reference to the metal can be found in most of the ancient Hindu, Chinese and Hebrew manuscripts, and in some, such as the Old Testament, it is the first metal mentioned. Gold beads, gold-hafted flint knives, stone jars with gold-covered mouths, gold ornaments, gold jewellery and various golden decorations have been found in the excavations of the most ancient civilizations, in the Neolithic monuments of France, in the Celtic graves of Europe, among the Sumerian relics of Ur, in predynastic monuments and graves of Egypt and among the very ancient remains of Minoan Crete, India and China. The tombs of the Pharaohs, especially that of Tutankhamen (c.1371–c.1352 B.C.), contained many beautifully executed gold pieces, and representations of quartz-crushing and gold-refining processes dating back to at least 1350 B.C. have been reported from these tombs. In the Code of Menes, who reigned in Egypt about 3500 B.C., it was decreed that "one part of gold is equal to two and one-half parts of silver in value." By 1000 B.C. both gold and silver were probably in widespread use as coinage metals in all countries between the Indus and the Nile. Other uses for gold mentioned in old manuscripts from various civilizations include the fabrication of idols, shrines, altars, bowls, vases, flasks, drinking cups, funeral face masks, sarcophagi, mummy cases and ornamental weapons. The art and trade of the goldsmith and minter have, therefore, come down to us from antiquity. Their story is told in magnificent detail by Singer (1954), Sutherland (1969), Blakemore (1971) and Hobson (1971).

The chemists and archaeologists tell us that the earliest gold objects of all ancient civilizations were fashioned directly from native gold (Caley, 1964; Hartmann and Sangmeister, 1972). Later, around the middle of the first millennium B.C., a method of purifying native gold came into existence, and at about the same time the practice of alloying metals such as silver and copper with gold and thus debasing the metal came into use[1]. It was apparently Archimedes, in his bathtub, who devised a means of determining the amount of alloyed metals, although it seems probable that his principle was known long before the advent of Greek science.

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[1]The practice of alloying metals with gold was called *diplosis* by the early Egyptian goldsmiths, meaning the art of 'doubling' the weight of gold without materially changing its outward appearance. In Colombia where platinoids were abundant in the early gold placers, the Spanish treasurers encountered no end of troubles with 'doubling' of the gold by individuals by means of alloying with the platinoids, elements unknown in Europe at that time (1750). It is said that to avoid this debasing practice that the treasurers ordered all of the platinum won from the placers to be thrown into the sea or nonauriferous rivers (Weeks, 1968).

The early metallurgy of gold probably involved little more than separating the metal by gravity from the dross of the placers and the quartz and other gangue of veins. Later, probably prior to 1000 B.C., it was discovered that gold adhered to mercury, and this developed into the amalgamation process that still finds a use in the treatment of gold ores. In the latter part of the 18th century and the greater part of the 19th the chlorination process was used extensively. Chlorine was passed through the moistened ore forming gold chloride which was leached out with water, the gold was then precipitated by ferrous sulphate. In 1887 McArthur and Forrest invented the cyanide process of dissolving gold followed by its precipitation with zinc dust. This is the method now commonly used on a large scale for the extraction of the element from its ores.

The extraction of gold and silver from sulphide ores by the process of liquation[2] was probably known to the ancients, as the Greeks seem to have been familiar with it and the Romans are known to have practised the art.

The process of 'parting' gold and silver by cementation with salt, whereby the silver is converted to chloride and the gold is run off, was apparently known in the 6th century B.C. Parting, employing acids, was unknown to the Romans. As far as can be determined, the first reference to the parting of gold and silver by means of nitric acid is to be found in the treatises of the Moslem alchemists of the thirteenth century. Modern processes of separating silver and other metals from gold involve the treatment of molten gold with chlorine and precipitation of the metal by electrolysis. The latter produces a pure product with only mere traces of silver, copper and other metals.

Native gold is a relatively common mineral and is present in gold-quartz veins, in oxidized zones of many sulphide and other types of auriferous deposits and in placers in streams and rivers in most parts of the world. It would seem that much of the gold of the ancients came first from placers and later from primary deposits and their oxidized zones. One of the richest placer streams which supplied much electrum to the Middle East, and is said to have been the source of the wealth of Croesus, was the river Pactolus (Sarabat), a tributary of the Hermus (modern Gediz) after passing Sardis in Lydia (now Anatolia, Turkey). The Pactolus drains the auriferous region on the flanks of Mount Tmolus (the present Boz Sira Daglari); it is the river in which it is said that Midas, the mythical founder of the Phrygian Kingdom, on the advice of Bacchus, bathed in its water to rid himself of the fatal faculty of turning everything he touched into gold. The other two legendary sources of gold, mentioned repeatedly in the Old Testament, Havilah and Ophir, have not been precisely identified.

In Genesis 2:10–12 it is written:

"And a river went out of Eden to water the garden; and from thence it was parted, and became into four heads.

"The name of the first is Pison, that is it which compasseth the whole land of Havilah, where there is gold;

"And the gold of that land is good: there is bdellium and the onyx stone."

There has been much speculation as to the location of the land of Havilah, the most probable from a geological viewpoint being that the river Pison is the modern Coruh which drains into the Black Sea near Batumi and that Havilah is the Pontic goldfield in Turkey, near Trabzon. This field is also probably one of the sites where Jason and the Argonauts sought the Golden Fleece, since within historical times placer miners used sheep's fleeces in this and other fields to catch the gold in their crude sluices. This method of winning gold (Frontispiece) is recorded by Strabo (63 B.C.–A.D. 19?), the Greek geographer, who wrote "the mountain torrents are said to bring down gold, and these barbarians catch it in troughs perforated with holes and in fleecy skins."

Strabo's reference is probably to the river Phasis (the present Rioni in Georgian S.S.R., draining from the Caucasus) which drained the Colchis region, supposedly the goal of the Argonauts in the legend of Jason. Whether or not this river produced gold in ancient times is uncertain. If it did, it is another of the possible sites where the legendary Golden Fleece was sought.

Ophir, the fabulously rich land of gold from which King Solomon's Phoenician (Tharshish) navy brought large amounts of the metal (some 34 metric tons) to his kingdom, has led to much speculation as to its location. In Genesis X it is associated with Havilah, which as noted above was probably the Pontic goldfield on the Black Sea. This may account for the long period of time, some three years, to make the voyage from Ezion-geber at the head of the Gulf of Aqaba to Ophir and back (I Kings 10:22). The cargos mentioned, almug (sandalwood) trees, precious stones, ivory, apes and peacocks suggest circumnavigation of Africa. Tharshish or Tarshish (a region centred on Cadiz) suggests that the gold may have come from Spain, and specifically from the oxidized deposits of the Huelva region where the modern mining town of Tharsis often equated with Tarshish is located. Other possibilities are East Africa, principally Rhodesia, and specifically the Zimbabwe region, where some think King Solomon's mines and metallurgical plants were located. This may also have been the site of Punt, exploited by the Egyptians, and from whence in Queen Hatshepsut's time (1600 B.C.) and later great store of gold was brought by the Egyptian navy. Still other possibilities suggested for the site of King Solomon's mines are southern Turkey (Bolkar Mountains), northwest Saudi Arabia (the land of the ancient Midians and possibly the Eldorado of the Hebrews), Sudan (Ancient Nubia; *Nub* means 'gold' in ancient Egyptian), Altai (Purington, 1903), Ethiopia, India, Cuba, Peru, the Far East, particularly Japan, Arctic Canada and a hundred other places. The story of Ophir is well told by Rickard (1932) and Sutherland (1969). The history of ancient Rhodesian gold mines and of Zimbabwe is related in fascinating detail by Summers (1969).

The most ancient map known, the famous *Carte des mines d'or* at Turin, is a Rameside papyrus and fragments depicting a gold mining region in Egypt. On it are located roads, miner's houses, gold mines, quarries, auriferous mountains and so on. The papyrus is said to date back to about 1320 B.C. The exact site represented by the map is in some

[2]In the process of liquation the copper, arsenic, etc., ores were first smelted often with a siliceous flux, to yield an impure ingot. This ingot was then alloyed with lead if there was insufficient lead in the ores, and the alloy was heated to a temperature between the melting point of lead and copper, during which the lead would liquate out, carrying the silver (and gold) with it. The lead was then cupelled on bone ash.

doubt. Some have suggested the mines represented are those of the Wadi Kareim or the Wadi Hammamat, on the Qena-Qoseir road (Gardiner, 1914). Derry (1951) says that the area represented on the map is the Wadi Fawakhir in which the El Sid Gold Mine is situated.

Gold has a widespread occurrence in practically every country in the world. In Europe, Asia and Africa ancient gold mines are known in Spain, Great Britain, Greece, Turkey, Saudi Arabia, Iran, India, China, Japan, U.S.S.R. (Uzbek S.S.R., Armenian S.S.R. and elsewhere) and numerous other countries. Placers have yielded gold from the rivers Tagus, Guadalquiver, Tiber, Po, Rhone, Rhine, Hebrus (Maritsa), Nile, Zambezi, Niger, Senegal, Pactolus (Sarabat), Oxus (Amu Darya which flows through the golden land of Samarkand), Ganges, Lena, Aldan, Yangtze and hundreds of others too numerous to mention. The Egyptians mined gold extensively in Sinai, eastern Egypt and Sudan (Nubia) as far back as 4000 years ago. It was from them that the Persians, Greeks and Romans learned the techniques of gold prospecting, mining and metallurgy. The Greeks and Romans mined gold ores extensively in the metalliferous regions of their empires (Davies, 1935; Tylecote, 1962; Healy, 1978). Pliny the Elder (A.D. 23–79) in his *Historia naturalis*[3] written in the early years of our era, repeatedly mentions the mining and metallurgy of gold, and Agricola[4] and many others before him refer to the element often in some detail. Rickard (1932, 1934, 1944) and Forbes (1964) have traced the history of gold mining, metallurgy and usage in great detail.

Compared with the gold placers and mines of the Old World those in parts of the New may be just as ancient, although it would appear that the Aborigines of North and South America put little emphasis on gold beyond its use as ornaments, jewellery, sacrificial knives, etc. Columbus of Genoa found the natives in possession of gold nuggets, a fact which excited the Spaniards to later pursue their conquests of Mexico and South America. Their avarice for gold and their ceaseless search for Eldorado, irregardless of the circumstances and cruelty they wrought on the natives, convinced the latter that the white man's god was 'gold'. The letter of King Ferdinand of Spain to his colonists in America dated July 25, 1511 would seem to bear this out for it commanded them[5] "Get gold, humanely if you can; but at all hazards get gold". The Spaniards were afflicted by the *auri sacra fames*[6] as are many individuals of our present civilization. In the pursuit of golden treasure, gods as well as men are often destroyed as in Wagner's great opera "Der Ring der Nibelungen" of which "Das Rheingold" is the prelude.

It seems certain from the accounts of Peter Martyr, Bernal Díaz del Castillo, José de Acosta and others that the Aztecs, Incas and the various peoples preceding them washed gold from placers with the gourd and *batea* (wooden pan) far back in antiquity. They probably also obtained much gold from the oxidized zones of various types of primary sulphide deposits, since they mined these extensively for silver long before the arrival of the Spaniards.

Gold has influenced the exploration and settlement of the Soviet Union, United States, Australia, South Africa and Canada in many ways. Even theories of the origin of gold deposits have been a factor in the history of Canada. It will be recalled that an early theory about the origin of gold deposits postulated that they developed under the celestial influence of the sun. From this it was easy to draw the conclusion that the largest number of gold deposits would be generated in the regions bounded by the Tropics of Capricorn and Cancer where the sun's influence was greatest. Columbus, in fact, wrote in his journal as he approached Cuba in 1492, that "From the great heat which I suffer, the country must be rich in gold." It will be further recalled that a dispute (Nootka Sound Controversy) arose between Spain and Great Britain over the sovereignty of the lands bordering the northwest coast of America. Spain contended she possessed sovereignty by authority of the Papal Bull of Alexander VI in 1493, but Britain took the view that rights of sovereignty could be obtained only through trade and the establishment of colonies. Spain meanwhile had established a settlement on Nootka Sound and in 1789 seized four British ships in the sound. This act nearly led to war but was finally resolved in favour of the British viewpoint in a convention signed on October 28, 1790. It appears probable that among the factors that influenced the Spanish decision was the advice given the Spanish king, Charles IV, that gold was unlikely to occur in the northern regions of America because it was thought that the element was generated only in those regions most influenced by the sun.

The Soviet Union has long been a legendary source of gold. The land of Colchis drained by the river Phasis (the modern Rioni) in Georgian S.S.R. is reputed by legend to have provided great quantities of gold. Similarly the Persians are said to have obtained much gold from the Scythians, a polyglot group of tribes that inhabited the region north of the Black Sea, and from various Iranian and other tribes who inhabited the Ural-Uzbek-Altai region. The golden road to Samarkand was known centuries before Christ. With time the monopoly of gold mining became the sole preserve of the Imperial Czars who pursued extensive placer and lode mining first in the Urals, beginning about 1774, and later in many parts of Siberia, especially in the Altai region where alluvial deposits were exploited as early as 1820. In 1829 the placer deposits of the Lena were first exploited and in 1840 those of the Yenisei Ridge came into production; the placers in the drainage system of the Amur were apparently first worked around 1867, and those in the Far Eastern Maritime area appear to have been first exploited around 1870 or earlier.

Gold washing and mining have a relatively long history in the United States. In New Mexico, Arizona and probably California, the Spaniards operated mines from which they obtained silver and possibly some gold at least as far back as 1620. There are also old records mentioning early discoveries of gold nuggets in California in the period 1775–1780 (Clark, 1970). Gold was also known to the Indians, Spaniards and early settlers in the southern Appalachian region where mining began about 1792 (Becker, 1895). These deposits though rich were relatively small and soon depleted. The scene

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[3] *Historia naturalis*, book XXXIII.
[4] Agricola, G., *De re metallica.*
[5] Helps, A., *The Spanish Conquest of America,* London, 1857.
[6] Quid non mortalia pectora cogis,
Auri sacra fames!

Accursed thirst for gold!
What dost thou not compel mortals to do.
–Virgil-Aeneid

then turned to California, to Coloma on the American River, where in the tail race of Sutter's Mill on the morning of January 24, 1848, James W. Marshall[7] plucked the first gold nugget from the sand that led to the great California gold rush of 1849–1850. There followed then in succession the discoveries of the Mother Lode and Grass Valley in California and the famous Comstock Lode in Nevada during the 1850's. The gold telluride deposits of Cripple Creek in Colorado were discovered in 1892, and by 1905 the Tonopah and Goldfield deposits in Nevada and the Alaskan placer deposits had been discovered.

Among the miners of the great California rush of 1849 was one Edward Hammond Hargraves, an Australian. After sojourning in California for some time and noting similarities in geology with areas where he had travelled in New South Wales he returned to the latter where, near Bathurst, on February 12, 1851 he discovered payable gold at the junction of Summer Hill Creek and Lewes Ponds (Lewis Pounds) Creek a tributary of the Macquarie River. This discovery led to the great gold rushes of Australia that have made that country famous as a gold producer. Previously (1823) gold was noticed by surveyor James McBrien in the Fish River between O'Connels Plain and Diamond Swamp north of the old Bathurst Road, near where the town of Oberon, New South Wales now stands. Many of the Australian miners stayed on to discover lead, zinc, copper, silver and tin deposits; others found a different 'Golden Fleece' on the grassy plains and hills of that fair continent. The history of the 'Midas Gullies' of Australia and of Australian mining is related in fascinating detail by Blainey (1969).

Gold was known to the Maoris long before the coming of the pakehas to New Zealand. However, there is little mention of the precious metal in the journals of the early explorers of New Zealand, and it was left mainly to the prospectors who had followed the great gold rushes to California and later to Australia to establish the presence of gold in commercial amounts. Alluvial gold was first discovered in 1852 at Coromandel (Hauraki Goldfield) North Island in Driving Creek by Charles Ring; later at Collingwood in Nelson, South Island in 1857; at Gabriels Gully in Otago by Gabriel Read in 1861; and in a number of sites along the western coastline of the South Island in 1864. Lode gold in the Hauraki Goldfield, the main centres being Waihi, Thames, Karangahake and Coromandel, was first exploited in the 1860's; the quartz deposits in Otago, South Island, were first worked in the 1870's; and the productive quartz lodes at Reefton produced their first gold in the early 1870's. The history of the discovery and mining of the gold deposits of New Zealand, of which there are many, ranging in age from Precambrian to Recent, is admirably told by Salmon (1963).

Gold and gold tellurides are widely distributed in the Fijian Islands, and the presence of these minerals was evidently known to the early Fijians. Baron A.B. de Este is said to have discovered gold in the Tavua area in 1872, but some 60 years were to pass before any serious prospecting was carried out. In 1932 Bill Borthwick and Jack Sinclair discovered payable gold on Vunisina Creek a small tributary of the Nasivi River. Further investigation of this prospect, which is associated with the Tertiary Vatukoula volcanic caldera, led to the development of a number of mines, of which the famous Emperor Mine has been in continuous production since about 1935. The history of prospecting in Fiji, and the development of the Emperor and other mines, is related in some detail by Fraser (1954).

Gold from West Africa found its way into Europe as early as the 10th century and probably before. Most of this gold came by Sahara caravan to Barbary and thence to Europe, the original sources being the Kingdoms of Ghana, Mali and Songhai. It is said that much of this gold came from a region known as Wangara (probably the basin of the Falémé, a tributary of the Senegal River and noted for its placers), but it seems more than probable that the gold had a much more widespread source considering the aurificity of West Africa. In any event one of the motives of the Portuguese voyages inspired by Henry the Navigator was to ascertain and exploit the west African gold. The Portuguese were soon followed by a host of English, French, Dutch and Spanish entrepreneurs. It is thought that annually more than a quarter of a million ounces of gold reached Europe during the 15th and 16th centuries from African sources.

In South Africa an historic event took place in 1834 when a Boer, Carel Kruger, while on a hunting expedition north of the Vaal River discovered gold on the Witwatersrand, or White Waters Ridge. Little attention was, however, paid to the find, the goldfields of Barberton and the DeKaap Valley being the chief focus of gold prospecting through 1885. In 1886 George Harrison, an Australian gold-digger, and George Walker, an Englishman, discovered payable gold reef on the Witwatersrand. This discovery soon led to the development of the great reefs which constitute the largest gold deposits known and which have made South Africa the foremost gold producer in the world. The story of the discovery of the remarkable deposits of the Witwatersrand, of the growth of Johannesburg and of the men who struggled for control, not only of the gold reefs, but of what is now South Africa is told in an admirable way by Cartwright (1962), Rosenthal (1970) and Robert Crisp in *The Outlanders* (Granada Publishing Limited, Mayflower Books Ltd.; Frogmore, St. Albans, Herts.; England, 1974).

There are a few references to gold in the annals of the voyages of Cabot, Jacques Cartier and Samuel de Champlain, and it is certain that these gentlemen explorers had an eye to the metal wherever they went. The references are, however, vague and the existence of gold in some of the sites mentioned appears doubtful. Jacques Cartier for instance in his second voyage[8] mentions that the Indians informed him that the people of the Kingdom of the Saguenay possessed a great store of gold and copper. Further, in the third voyage[9] he mentions diamonds and flakes of fine gold as thick as a man's nail near Cap-Rouge, southwest of Quebec City. In Roberval's[10] account of his voyage in 1542–1543, he records that Cartier brought to St. John's in Newfoundland diamonds and a quantity of gold ore which he found in the country of

[7]Del Mar (1880, p. 165) says that it was Marshall's daughter who first discovered gold in the tail race of Sutter's Mill.

[8]Biggar, H.P.; *The voyages of Jacques Cartier,* Publications of the Public Archives of Canada, No. 11, 1924, p. 201.
[9]*Ibid.,* p. 255.
[10]*Ibid.,* p. 264.

Canada. On being tried in the furnace, the ore was found to be good (i.e., it apparently contained gold)[11].

The initial quest for gold in Canada is a story of ignorance and knavery, involving the explorer Martin Frobisher, and one, a promoter and London merchant, Michael Lok by name (Low, 1906; Rickard, 1944; King, 1955; Cooke, 1964; Bruemmer, 1966; Blackadar, 1967; Kenyon, 1975). On the first voyage in 1576 Frobisher brought Lok a dark glittering stone from Hall Island which government assayers, among them the Queen's assayer of the Tower (the Mint), declared worthless but which an alchemist, the Italian John Baptista Agnello (or Angello ?), by 'coaxing nature' found the stone to be high grade gold ore. This was sufficient to promote a second voyage in 1577 by Frobisher, who on an island (Countess of Warwick Island) in Frobisher Bay "found good store of Ore, which in the washing held golde plainly to be seene." Two hundred tons of the ore were mined and the expedition returned to England where Commissioners for the Adventurers to the Northwest for the Discovery of a Northwest Passage and others examined the material and pronounced it to be worth as much as £67 and more in gold and silver. The next year Frobisher, under the auspices of the Company of Cathai, set sail with 15 ships and mined some 1350 tons of ore from the Countess of Warwick Island and other areas in Countess of Warwick Sound before returning to England. On their return they received the unpleasant news that the cargo was worthless, contained no gold, but only pyrite (marcasite ?) and a bronze mica, probably biotite. And so the venture ended: Lok found himself in debtors' prison; Frobisher remained free but in some disfavour with the Queen and others who had financed the mining venture. All that remains of this gold venture are a few rockcuts, small quarries and trenches in the rocks on and around what is now called Kodlunarn Island and a reminder that "all that glisters is not golde."

[11]For some years I have been interested in these references and have attempted to verify the sites and the presence of gold at them. The Kingdom of Saguenay was apparently bounded by the rivers Chamouchouan, Saguenay, St. Lawrence, Ottawa and Gatineau. There is gold in some of the deposits of this area, viz. Tetreault deposit near Quebec City, and the goldfields of Quebec and Ontario lie just to the north and west. I have, however, not been able to discover evidence of any ancient workings in the Kingdom of the Saguenay, nor have I seen any evidence of placer gold. There are, however some strange references to the presence of white men inhabiting this kingdom as related by the Indians to Cartier (*Ibid.*, p. 221), and one wonders if we are not here dealing with Norsemen or Spaniards who mined or washed gold somewhere in Ontario or Quebec. I suspect that the Wanapitei Lake and Vermilion River areas of Ontario where placer gold is known may have been the sites of some of the early Norse gold washings. That the Spaniards also penetrated parts of Ontario in search of gold also seems probable to me, and this may be the reason for the portrayal on one of the maps in Cartier's journal of men who resemble Spanish miners. According to legend, the Spaniards apparently called Canada 'Capa de Nada' (Cape with nothing) signifying that they found little if any gold in the country.

As for the diamonds at Cap-Rouge this is evidently an error in mineralogy. The minerals referred to are quartz crystals as has been suggested by others. I have also been unable to find any gold at this site nor can I find any reference to gold ever having been obtained anywhere along the North Shore of the St. Lawrence near Quebec City. Cartier could, however, have obtained gold from the Indians who may have picked it up along the Chaudière River which as mentioned below is gold-bearing. The gold ore that proved at St. John's to be good seems not to have stood the test of further analysis, otherwise one would have thought that Cartier or others would have been interested in examining and exploiting the occurrence or occurrences by further sampling and mining.

The first authentic discovery of gold in Canada is related by Lieutenant, later General, W.W. Baddeley of the Royal Engineers in the American Journal of Science, v. XXVIII, July 1835, p. 112–113, as follows:

> I have to inform you of two interesting facts, which have been lately ascertained respecting Quebec and its vicinity. The first is that native gold has been picked up, about thirty miles to the southward of this metropolis; it was met with, in a small stream running into the Chaudiere, and over a region, as I suspect, (for I have not visited the *precise* locality), of talcose slate. A similar specimen was found in the same neighbourhood several years ago. That in question is of a flat ovate form, weights 10.63 grains, and has a sp. gr. of 15.7. The geological associations of this ore appear to be analogous to those of the Russian and American localities and when we consider them all, additional probability is given to the conjecture, expressed by Professor Eaton, at page 52, Vol. 18 of the American Journal of Science.
>
> It is worthy of notice, that in the neighbourhood of the place where the gold was found, two or three Canadian peasants have been mining for several years past. About the year 1825, I visited the scene of their operations, and found a shaft, ten feet cube, sunk in talcose slate, the predominating rocks at hand being of serpentine. I have lately been informed that the depth of this shaft, is now upwards of fifty feet. At the period of my visit, silver was said to be the object of search, and presuming that they had mistaken the deceptive lustre of the silvery talc for that of this metal, I endeavored to dissuade them from so ruinous a pursuit. Nothing has yet transpired as to their success, which is generally considered not to have been encouraging, and yet it is scarcely conceivable that they would persevere through so many years, without being stimulated to do so by some substantial return, a consideration which joined to what is stated above, renders it not improbable that they have met with some small deposits of gold.

The exact locality appears to have been in the Seigniory of Rigaud-Vaudreuil, the property of the heirs of Charles Etienne Chaussegros de Léry, Esq., on a small stream called the Touffe des Pins, a tributary on the right bank of the Chaudière about 58 mi from Quebec (Geol. Surv. Can., Report of Progress, 1847–1848, p. 76–77).

From the Chaudière the scene shifted to British Columbia, and specifically to that great tempestuous river, the Fraser, named in honour of Simon Fraser, that intrepid Scottish explorer who descended it to a point near its mouth in 1808. Strange as it may seem, Fraser noticed no gold in the river despite the fact that it is gold-bearing from its mouth to its source. In any event as the years rolled on, the Hudson's Bay Company began buying gold from the Indians, the largest amount being purchased by Chief Trader McLean at Fort Kamloops in 1852. It seems that much of this gold may have come from the Thompson River for James Douglas in a memorandum dated 1860 remarked:

> Gold was first found on Thompson's River by an Indian, a quarter of a mile below Nicoamen. He is since dead. The Indian was taking a drink out of the river. Having no vessel he was quaffing from a stream when he perceived a shining pebble which he picked up and it proved to be gold. The whole tribe forthwith began to collect the glittering metal.

Rickard (1942) says that this initial discovery was probably in 1857, but it would appear to have been much earlier. The same author also relates that the earliest discovery of gold in British Columbia to arouse public interest was made around 1850 by an Indian on one of the Queen Charlotte Islands. Whatever the source of the gold purchased by Chief Trader McLean it appears that it was the sale of this gold, some say 800 oz, in San Francisco that attracted miners north to the Fraser. In 1855 flour or skim gold was discovered on

the bars of the lower Fraser, but this attracted little attention. Moving northward coarse gold was found on the Nicoamen River above Lytton in 1857, and by 1858 the rich bars at Yale were being worked. The news of these discoveries was followed by an extraordinary migration from the goldfields of California to those of British Columbia. Following the golden stream of the Fraser ever northward, the miners reached the fabulously rich gravels of the Cariboo. The initial discovery of this famous camp in June, 1859 is described by Art Downs in his *Wagon Road North*[12] as follows:

> In the vanguard was a party of Americans, Peter Dunlevy, Jim Sellers, Ira Crow, Tom Moffit, and Tom Manifee. At the junction of the Chilcotin and Fraser Rivers they met a huge Indian who called himself "Tomaah". He wondered what the miners were doing and they showed him the flakes and nuggets from the bars. Tomaah scoffed and said he could show them a river where gold lay like beans in a pan. But, he explained in his pidgin English, the men must wait. He was currently employed by the Hudson's Bay Company and could not yet leave his job. In a few days he would meet them and show them the river.
>
> He returned as promised and took the party to his tribal encampment. Here he introduced them to another Indian, Long Baptiste, a majestic specimen over six feet tall with broad shoulders and narrow waist. It developed that Tomaah was in love and didn't want to leave, but Baptiste would act as their guide, and in June he led the miners through the wilderness to a river now called the Horsefly. Here they found the nuggets like beans in a pan. And although the excited men weren't concerned, they also became the first white men to pan gold in a region soon to become world famous – the Cariboo.

Others sought elsewhere along the golden stream and in 1860 richer gravels were located at Quesnel Forks and on Keithley and Antler creeks. In 1861 the celebrated Williams and Lightning creeks were discovered. The golden creeks of the Cariboo ultimately lured men to all parts of British Columbia and in the years that followed gold was discovered in a hundred streams, from the United States border to Yukon and beyond.

Meanwhile, in Nova Scotia lode mining of gold held the scene, the first indications of a profitable quartz lode having been found by Lieutenant C. L'Estrange while moose hunting in 1858 in the Mooseland area on the Tangier River. This discovery ultimately led to the mining of gold from numerous deposits of the gold-bearing Meguma Group. Previous to the discovery of lode gold, Heatherington[13] points out that the native metal was probably known to the early Acadians in Cape Breton Island, hence the French names – Bras d'Or, Cape d'Or and Jeu d'Or (now corrupted into Jeddore). This could well be true since gold deposits are known at Whycocomagh and Middle River in the central part of Cape Breton Island. One, John Campbell, a resident of Dartmouth discovered alluvial gold in 1857 in the sands of Fort Lawrence in Halifax Harbour, and it seems probable that discoveries of alluvial gold were made at Isaac Harbour, Sherbrooke, Ovens and elsewhere in Nova Scotia as early as 1830 (Malcolm, 1912, p. 3–4).

In the Canadian Shield, lode gold was first discovered in 1866 near Madoc, Hasting County, Ontario by a part-time prospector, Marcus Herbert Powell. This later became known as the Richardson mine from the name of the owner of the farm on which the gold was discovered.[14]

Other discoveries were made in the years following in the same area, and in northwestern Ontario near Port Arthur and in the Lake of the Woods area. Following the discovery of silver at Cobalt in 1903, prospectors ranged widely over the Precambrian areas of Ontario, Quebec and Manitoba. In Ontario and Quebec, Abitibi and Larder Lake were discovered in 1906; Porcupine, 1909; Swastika, 1910; Kirkland Lake, 1911; Matachewan, 1916; Rouyn (Noranda), 1924; and Red Lake, 1925. In Manitoba the Rice Lake district was discovered in 1911, and in Northwest Territories, the deposits in the sediments of the Yellowknife area were discovered in 1933 and those in the greenstones in 1935.

But we must go back more than 35 years to one of the greatest gold rushes of history – that of the Klondike in Yukon.

Discoveries of gold were reported on the Yukon River as early as 1869, and further important placers were located in 1878 on tributaries of this legendary river. It was not until 1896, however, that the fabulously rich placers of the Klondike River, a right bank tributary of the Yukon were located. Pierre Berton,[15] in his book *Klondike,* records the initial discovery thus:

> Carmack tried the prospects at Gold Bottom, but did not stake, and the trio headed back over the mountain almost immediately. The way was hard. They struggled over fallen trees and devil's clubs, a peculiarly offensive thorn, and they forced their way through interlaced underbrush, brier roses, and raspberry bushes. On the far side of the mountain they floundered into a niggerhead swamp that marked the headwaters of Rabbit Creek, and here they had to hop from clump to clump on their slippery moccasins or sink to their thighs in the glacial ooze. Hordes of gnats and mosquitoes rose about them as they stumbled on, unable to swat the insects for fear of losing balance.
>
> Thus they came wearily to the fork of Rabbit Creek once more, and pressed on for about half a mile before making camp for the night. It was August 16, the eve of a memorable day that is still celebrated as a festive holiday in the Yukon Territory.
>
> Who found the nugget that started it all? Again, the record is blurred. Years afterward Carmack insisted it was he who happened upon the protruding rim of bedrock from which he pulled a thumb-sized chunk of gold. But Skookum Jim and Tagish Charley always claimed that Carmack was stretched out asleep under a birch tree when Jim, having shot a moose, was cleaning a dishpan in the creek and made the find.
>
> At any rate, the gold was there, lying thick between the flaky slabs of rock like cheese in a sandwich. A single panful yielded a quarter of an ounce, or about four dollars' worth. In a country where a ten-cent pan had always meant good prospects, this was an incredible find. Carmack flung down the pan and let out a war whoop, and the three men began to perform a wild dance around it – a sort of combination Scottish hornpipe, Indian fox trot, syncopated Irish jig, and Siwash hula, as Carmack later described it. They collapsed, panting, smoked a cigarette apiece, and panned out some more gravel until Carmack had gathered enough coarse gold to fill an empty Winchester shotgun shell. Then they settled down for the night, the Indians chanting a weird song of praise into the embers of the fire while Carmack, staring at the dying flames, conjured up visions of wealth – of a trip around the world, of a

[12]Downs, Art; *Wagon Road North,* the story of the Cariboo gold rush in historical photos; Northwest Digest Ltd., Quesnel, B.C., 1960.

[13]Heatherington, A; *Goldfields of Nova Scotia,* John Lovell, Printer, Montreal, 1868, p. 20.

[14]For an interesting piece of Canadiana about prospecting for gold and other metals in the Madoc gold area and other places in Canada, United States and British Columbia see, *The Gold-Seekers Handbook and Practical Assayist,* published by S. Vivian, Bookseller, Napanee, Ontario, 1867.

[15]Berton, Pierre; *Klondike*, McClelland and Stewart, Limited, Toronto, 1958.

suburban mansion rimmed with flower borders, or a suitcase full of gilt-edged securities. In that instant of discovery something fundamental had happened to Siwash George: suddenly he had ceased to be an Indian. And he never thought of himself as an Indian again.

The following morning the trio staked claims on Rabbit Creek. Under Canadian mining law, no more than one claim may be staked in any mining district by any man except the discoverer, who is allowed a double claim. Carmack blazed a small spruce tree with his hand ax, and on the upstream side wrote with a pencil:

TO WHOM IT MAY CONCERN

I do, this day, locate and claim, by right of discovery, five hundred feet, running up stream from this notice. Located this 17th day of August, 1896.

– G.W. Carmack

While Carmack made the discovery which led to the historic rush to the Klondike he was not the true discoverer of the great gold placers. Rather, one Robert Henderson staked the first claims on the gold creeks of the Klondike, specifically on what is now called Gold Bottom Creek. The sequence of events is told in a letter to the Engineering and Mining Journal Press (February 17, 1923, p. 305–306) by A. E. Wills and corroborated by Henderson himself in a letter to the same journal (June 9, 1923, p. 1009) in which he states:

George Carmack and the Indians were camped at the mouth of the Klondike, and I gave him the information, asked him to come up, and told him the easiest route to take to reach my discovery. They came, and it was on their way back to the mouth of the Klondike that they made their discovery on Rabbit Creek (now called Bonanza Creek). Carmack and his two Indians staked next to me on Gold Bottom Creek, but I believe they did not record the Gold Bottom staking.

My discovery on Gold Bottom was made in July, 1896. I had no calendar, but as nearly as I could determine the date it was the fifteenth of July.

Green (1977) in his recent book *The gold hustlers* has chronicled the history of the Klondike from its discovery, through its hey-day, to the present. Today only small operators work the placers, the days of the great dredges being past, at least until there is a marked increase in the price of gold.

We see that gold has had a long history, and we shall see in what follows that gold is many things to many men. To the geochemist it is a rare metal, the geochemistry of which is intricate and complex; to the mining engineer and metallurgist it presents a challenge of extraction from the earth and from its ores; to the artist, goldsmith and jeweller it is a metal of superb and everlasting beauty; to the industrial artist it is a metal with unique properties useful in electronics and many other artifacts of man; to the numismatist it is a coinage metal with a long and interesting history; and finally to the economist a valuable standard against which wealth is measured and an imperishable medium for balancing international accounts. In literature the word gold and its derivatives appears more often than any other word, creating legends, tinging metaphor and simile and providing innumerable parables, analogies and proverbs.

The term *gold* is said by the scholars to come from the Sanskrit *jvalita* derived from *jval,* to shine. Our word *gold* derives from the Anglo-Saxon, *gold,* a word apparently corrupted from the Teutonic, *gulth,* the glowing or shining metal. The Latin term for gold, *aurum,* and the earlier Sabine *ausum* are said to be words of early Italian origin related to *aurora* meaning the glowing dawn. Another version has it that the Latin word, *aurum,* derives from the Hebrew, *aor,* meaning light. The Latin term is preserved in the chemical symbol for gold, Au, and in the terminology of its salts, *aurous* and *auric.*

The Egyptians used the most perfect of planar geometric figures, the circle, as the symbol for gold, the most perfect and noblest of the metals. The alchemists associated gold with *Sol* (the sun) or with the Greek sun-god Apollo and represented it by the symbol of perfection, the circle with a dot at the centre, or by the circle with a crown of rays to represent the king or Apollo of metals. To the early Hindu philosophers gold was the 'mineral light'; to the early Western philosophers the metal was the image of solar light and hence of the divine intelligence of the universe.

There is an extensive bibliography on the history of gold in Gmelin (1950).

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During my research on gold deposits I have visited and

worked in many mines throughout the world and in places have had access to various private company reports, assays, bullion returns, etc. Everywhere, I have been courteously treated for which I thank collectively the many mine managers and geologists with whom I have come in contact. I hope this book will serve them well in their further search for gold.

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The quotation about the discovery of the Cariboo is included with permission of Art Downs from his *Wagon Road North* published by Northwest Digest Ltd., Quesnel, B.C., and the quotation about the discovery of the Klondike is published by permission of Pierre Berton and McClelland and Stewart Limited, Toronto from the book *Klondike.* To both these men and their publishers I extend my sincere thanks. The golden cups of Vaphio are reproduced by permission of the Director, E. Thanos, National Archaeological Museum, Athens, Greece and the coloured photograph of the remarkable gold specimen from the Timmins (Porcupine) gold belt of Ontario was provided by the Mineralogy Department, Royal Ontario Museum, Toronto.

A note about the references: Malcolm Maclaren, in his classic treatise on gold written in 1908, remarked that the literature on gold was stupendous. Nearly 70 years later there is no superlative adjective adequate to describe the amount of literature available on the element. In the Selected bibliography I have attempted to include all of the papers and books published up to the end of 1977 that one would require in researching the details of the features of the gold-bearing belts of the world together with those on the geochemistry of the element. I extend my apologies to those whose papers could not be included mainly because of space considerations. Where possible, references to English abstracts of foreign publications appearing in Chemical Abstracts and other abstract journals are included with the original references.