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A study of the trace elements associated with gold from the Barberton District

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following possible trace constituents: aluminium, arsenic, boron, bismuth, calcium, cadmium, cobalt, chromium, mercury, magnesium, manganese, molybdenum, nickel, lead, palladium, platinum, rhodium, antimony, silicon, tin, strontium, tellurium, titanium, vanadium, tungsten, zinc and zirconium. Table IV summarizes some of the reported compositions of native gold.

Crook (1939) spectrographically analyzed samples of native lode and placer gold. He found that the lode gold contained copper, iron, silver, molybdenum, lead, nickel, vanadium and aluminium, whereas the placer gold contained only iron, silver, nickel, copper and aluminium. Silver, copper and iron were common to all the samples analyzed and were, Crook suggested, constant associates of gold.

Vein gold from the Belgian Congo was found by Van Aubel (1935) to contain silver, iron, lead and bismuth as the major constituents, in addition to arsenic, boron, copper, molybdenum, antimony, tin, titanium and zinc. Samples of gold collected from different levels of the Baleisk Mine, Transbeikalia, were analyzed by Zviagintsev et al (1938). The results showed no variation in the composition of the gold from the surface to a depth of 120 metres. Miyazawa (1953) found that native gold from the Daikoku deposit, Japan, contained 10.17% silver and traces of copper, lead, bismuth, zinc, iron, silicon, calcium, aluminium and magnesium.

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Table IV. Reported compositions of native gold.

Description	Composition	Reference
Average composition of native gold.	Ag, Bi, Cu, Fe, Hg, Pb, Pd, Rh, Sb, Sn.	Rose and Newman (1937).
Coated gold.	Ag, Al, Fe, Mn, Pb, Ti	Head (1935).
Lode gold, source unknown.	Ag, Cu, Fe, Mo.	Crook (1939).
Nugget	Ag, Bi, Cu, Fe, Pb, Sb.	Fer'yanchich (1959).
Lode Gold, Barberton	Ag, As, Cu, Fe, Mn, Ni, Pb, Sn, Si.	Steele and Carlton (1961).
Lode gold, Trichardts Luck, Barberton.	Ag, As, Cu, Fe, Mn, Ni, Si, Sn.	Steele and Carlton (1961).
Lode gold, Lily Mine, Barberton.	Ag, As, Cu, Fe, Mn, Ni, Sb, Si.	Steele and Carlton (1961).
Native gold, Matloui, Southern Rhodesia.	Ag, Cu, Fe, Hg.	Warren and Thompson (1944).
Native gold, Barberton.	Ag, Cu, Fe, Hg, Ti, V.	Warren and Thompson (1944).
Native gold, Golden Valley, S. Rhodesia.	Ag, Cu, Fe, Hg.	Warren and Thompson (1944).
Native gold, Urega, Kivu, Belgian Congo.	Ag, As, B, Bi, Cu, Fe, Mo, Pb, Sb, Sn, Ti, V.	Van Aubel (1935).
Nugget, Nyongwe, Ruanda-Urundi.	Ag (7.57%), Cu (0.4%)	Gastelier, Peeters and Sorotchinsky (1947).

Table IV, continued.

Description	Composition	Reference
Nugget, Bumva district Ruanda-Urundi.	Ag (15.8%), Ca (0.5%), Fe (0.2%), Mg (0.1%)	Gastelier and Sorotchinsky (1947).
Lode gold, Melanes Mine, California.	Ag, Cu, Fe, Pd.	Crook (1939).
Lode gold, Idaho Maryland Mine.	Ag, Al, Cu, Fe.	Crook (1939).
Lode gold, Empire Mine, California.	Ag, Cu, Fe, Ni.	Crook (1939).
Lode gold, Gold Hill, Yukon Territory.	A g, Cu, Fe, Hg, Ti.	Warren and Thompson (1944).
Lode gold, Usk, British Columbia.	Ag, As, Bi, Cd, Cu, Fe, Hg, Sb, Sn, Te, Ti, V.	Warren and Thompson (1944).
Lode gold, Copper Mountain, British Columbia.	Ag, Cu, Fe, Hg, Mn, Pd, Pt, Sb, Sn, Ti, V.	Warren and Thompson (1944).
Nugget, Arizona Creek, Yukon Territory.	Ag, Cu, Fe, Hg, Mn, Pb, Sb, Sn, Ti, Zn.	Warren and Thompson (1944).
Nugget, Klondyke Valley, Yukon Territory.	Ag, Cu, Fe, Ti.	Warren and Thompson (1944).
Nugget, Klondyke.	Ag, Al, Cu, Fe, Sb, Ti.	Crook (1939).
Nugget, Placer Juarez, California.	Ag, Al, Cu, Fe.	Crook (1939).

Table IV, continued.

Description	Composition	Reference.
Nugget, Trinity Co., California.	Ag, Al, Cu, Fe, Ti.	Crook (1939).
Lode gold, Con System Yellowknife.	Ag, Al, As, Bi, Ca, Cu, Fe, Hg, Mg, Pb, Sb, Si, Ti, V.	Boyle (1961).
Lode gold, Negus-Rycon System, Yellowknife.	Ag, Al, As, Bi, Ca, Cu, Fe, Hg, Mg, Pb, Sb, Si, Ti, V.	Boyle (1961).
Lode gold, Giant System, Yellowknife.	Ag, Al, Bi, Cu, Fe, Mg, Si, Sr, Ti.	Boyle (1961).
Gold from ice lens, Giant Mine, Yellowknife.	Ag, Al, Cu, Fe, Mg, Si.	Boyle (1961).
Lode gold, Campbell System, Yellowknife.	Ag, Al, As, Ca, Cu, Fe, Hg, Mg, Pb, Sb, Si, Ti, V.	Boyle (1961).
Lode gold, Ptarmigan veins, Yellowknife.	Ag, Al, Cu, Fe, Pb, Si.	Boyle (1961)
Lode gold, San Mauricio, Philippines.	Ag, Cu, Fe, Mn, Pb, Sb.	Warren and Thompson (1944).
Native gold, Chichibu Mine, Japan.	Ag, Al, Bi, Ca, Cu, Fe, Mg, Pb, Si, Zn.	Miyazawa (1953).
Native gold, Woiz, U.S.S.R.	Ag (9.45%), Cu (0.35%)	Nenadkewitch (1909).
Native gold, Shilovo-Issetsk, U.S.S.R.	Ag (2.84%), Bi (2.92%), Cu (0.11%)	Nenadkewitch (1909).

Table IV, continued.

Description	Composition	Reference.
Native gold, Freiberg, Germany.	Ag, As, Bi, Cd, Cu, Fe, Ge, Mn, Pb, Sb, Sn, Ti, Zn.	Rentzsch (1961).
Nuggets, Ivalo River, Finnish Lapland.	Ag (9.6%), Cu, Fe (Cu + Fe = 0.89%)	Sundell (1936).
Placer gold, Outokumpu Mine, Finnish Lapland.	Ag (7.33-10.45%), Al(0.08-.10%), Co,Cr, Cu (.006-.008%) Fe (.011-.10%), Mn (.001-.002%), Ni, Pb, Pt, Sb, V,W,Zn.	Wilska (1952).
Placer gold, Lemmenjoki, Finnish Lapland.	Ag, Al, As, Bi, Co, Cr, Cu, Fe, Mn, Ni, Pb, Sb, Sn, Te, Ti, V, Zr.	Wilska (1952).

Summary of above table:

Total number of analyses - 42.

Number of analyses in which the individual elements are present: Ag - 48; Al - 14; As - 10; B - 2; Bi - 12; Ca - 5; Cd - 2; Co - 2; Cr - 2; Cu - 45; Fe - 44; Ge - 1; Hg - 13; Mg - 12; Mn - 12; Mo - 2; Ni - 6; Pb - 19; Sb - 16; Si - 10; Sn - 10; Sr - 1; Te - 3; Ti - 19; V - 12; W - 1; Zn - 5; Zr - 1.

Native gold from British Columbia ore deposits was spectrographically analyzed by Warren and Thompson (1944). The elements detected included silver, copper, iron, manganese, vanadium, titanium, mercury, lead, bismuth, tellurium, arsenic, antimony, zinc, cadmium, tin, palladium and platinum. Silver, copper and iron were found in all the samples, the iron being present in approximately constant amounts. Cadmium was found in 14 samples, only three of which contained zinc, an unexpected result when it is remembered that these two elements are commonly associated in sphalerite. Tellurium, lead and bismuth generally occurred together. The authors concluded that the type of deposit could affect, but not control the trace element composition of the gold. Mercury, for example, was found in xenothermal, mesothermal, epithermal and pyrometasomatic deposits. Tin occurred in all types of deposits, especially those of high temperature. The results indicated that the association between gold and its trace elements was controlled by the particular metallogenetic zone and that the association was probably chemical in nature, rather than mechanical, implying a common origin for the gold, mercury and tin. Therefore, it was possible for gold from a particular metallogenetic province to have a characteristic trace element assemblage.

Regional surveys of the composition of native gold have also been carried out by Wilska (1952) in Finnish Lapland, and Boyle (1961) in the Yellowknife District, Canada. Wilska found that silver was

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the main constituent together with copper, iron, aluminium and manganese. Platinum, tellurium and bismuth were not common in Finnish gold. Boyle analyzed gold from different shear zones and found that all the samples had approximately the same composition, silver, arsenic, bismuth, copper, iron, lead, mer[illegible] and antimony being present in the gold lattice. Other elements such as calcium, aluminium, titanium, magnesium, boron, strontium, vanadium and silicon were probably present as small inclusions of quartz, carbonate and sericite.

Analyses of gold from Southern Africa include the results obtained by Warren and Thompson (1944) and Steele and Carlton (1961), (see Table IV). Warren and Thompson found that the two gold samples from Matloui and Golden Valley in Southern Rhodesia, contained copper, silver, iron and mercury. A sample of gold from Barberton contained vanadium and titanium in addition to the above four elements. Steele and Carlton found silver, copper, arsenic, iron, manganese, nickel, lead, silicon, antimony and tin in three samples of gold from the Barberton district. In addition, Liebenberg (1955) mentioned the presence of mercury in visible gold from the Carbon Leader (Blyvooruitzicht Gold Mine) and the Kimberley Reefs (Sub Nigel Gold Mine).

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(d) The fineness of gold

With regard to the fineness of gold, it is generally assumed that placer gold is finer than the lode gold from which it is derived. This is suggested to be due to a surface refining action during transport of the gold involving removal of silver relative to gold (Fisher, 1945). However, very fine gold has also been reported from veins. For example, Maclaren (1908) reported gold of 999.1 fine at the Great Boulder Mine, Kalgoorlie; 999 fine at Cripple Creek, Arizona and 997 fine at Mount Morgan, Queensland. These exceptionally high finenesses are probably due to the refining of the gold in the oxidized zone of the ore deposits. Knopff (1913) found that unoxidized gold at Mount Morgan was only 570 fine compared to gold of 998 fine in the oxidized zone.

Variations in the fineness of gold ores with definite physical factors have been reported by many workers. Decrease in fineness with increasing depth has been recorded by MacGregor (1928) for the ore of the Lonely Mine in Southern Rhodesia; Bruce (1943) for various Canadian gold mines and Sharwood (1911) for ore from the Homestake Mine, South Dakota. This decrease in fineness may be due to secondary enrichment of gold in the oxidized zone and, assuming this, Mackay (1944) argued that fineness should decrease until the primary mineralization is reached, when it should remain constant. However, Fisher (1945), noting that gold is less soluble than silver,

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suggested that the fineness should increase with depth. He substantiated this argument by reviewing gold finenesses from deposits throughout the world and found that hypothermal gold was always greater than 800 fine, mesothermal gold varied from 750 - 900 fine and epithermal gold ranged from 500 - 800 fine. Colin (1946) reached similar conclusions for gold from the Macequece field, Madagascar. Similarly, Mills (1954) found that the fineness of the ore of the O'Brien Mine in Quebec behaved as Fisher predicted and Hargraves (1961) found that the upper reefs on the Witwatersrand were richer in silver than the lower ones.

The fineness has also been found to vary laterally in individual deposits and over a whole mining area. Sharwood (1911) reported a variation in fineness along the Homestake lode and Lawn (1924) and Prentice (1939-40) found that the silver content in Witwatersrand ores increased from west to east.

Grain size is also a factor which affects the fineness of gold ores. Generally, for lode gold, the larger grains are finer than the smaller ones (Collins, 1902; Sharwood, 1911; Prentice, 1939-40; Mackay, 1944). The reverse relationship has been reported by Mills (1954) and Eales (1961). For placer deposits the finer-grained gold is usually purer than the coarser material (Hite, 1933; Sundell, 1936; Frankel, 1939).

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Fineness variations with grade of ore have also been observed, the value generally increasing with increasing grade of ore. This increase has been noted on Witwatersrand mines by Lawn (1924), Prentice (1939-40) and Richardson (1939-40). In vein deposits, Mackay (1944) noted a decrease in fineness with decreasing grade for the ore of the Lupa goldfield, Tanganyika. Macgregor (1928) and Eales (1961) recorded the same variation in Southern Rhodesian mines and Eales found that for the ore of the Olympus Mine an increase in grade of 1 dwt/ton was accompanied by an increase of 30 - 35 parts per thousand in the fineness. Edwards (1958), while agreeing in general with these observations, found patches of gold of very high fineness occurring in low grade ores from the Maude and Yellow Girl Mine in Australia.

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THE ANALYSIS OF THE GOLD SAMPLES

A. THE PRE-ANALYTICAL TREATMENT OF THE SAMPLES

(a) The collection of the samples

Forty samples of visible gold were collected from mines and workings in the Barberton area. The samples consisted mainly of panned concentrates and chip samples and will, in future discussion, be referred to as the G series of samples. The G series were supplemented by a further six samples from Witwatersrand and Southern Rhodesian localities. Figure 1 is a simplified geological map showing the approximate location of the Barberton samples. Twenty-two samples were, in addition to the above, collected along the Zwartkopje shoot at the Sheba Mine, between the 14 and 26 levels, covering a distance of 1271 feet. These samples will in future be referred to as the S series of samples. Specimens were taken at different levels along the shoot to allow for any vertical variation in composition, three samples being collected at different positions on the same level, when possible. Tables V and VI give the localities of the G and S series of samples, respectively, together with the host rock and associated minerals (if possible), a description of the gold, the amount of gold extracted and the analyses to which the samples were subjected.

The method of sampling is open to criticism in that it has been

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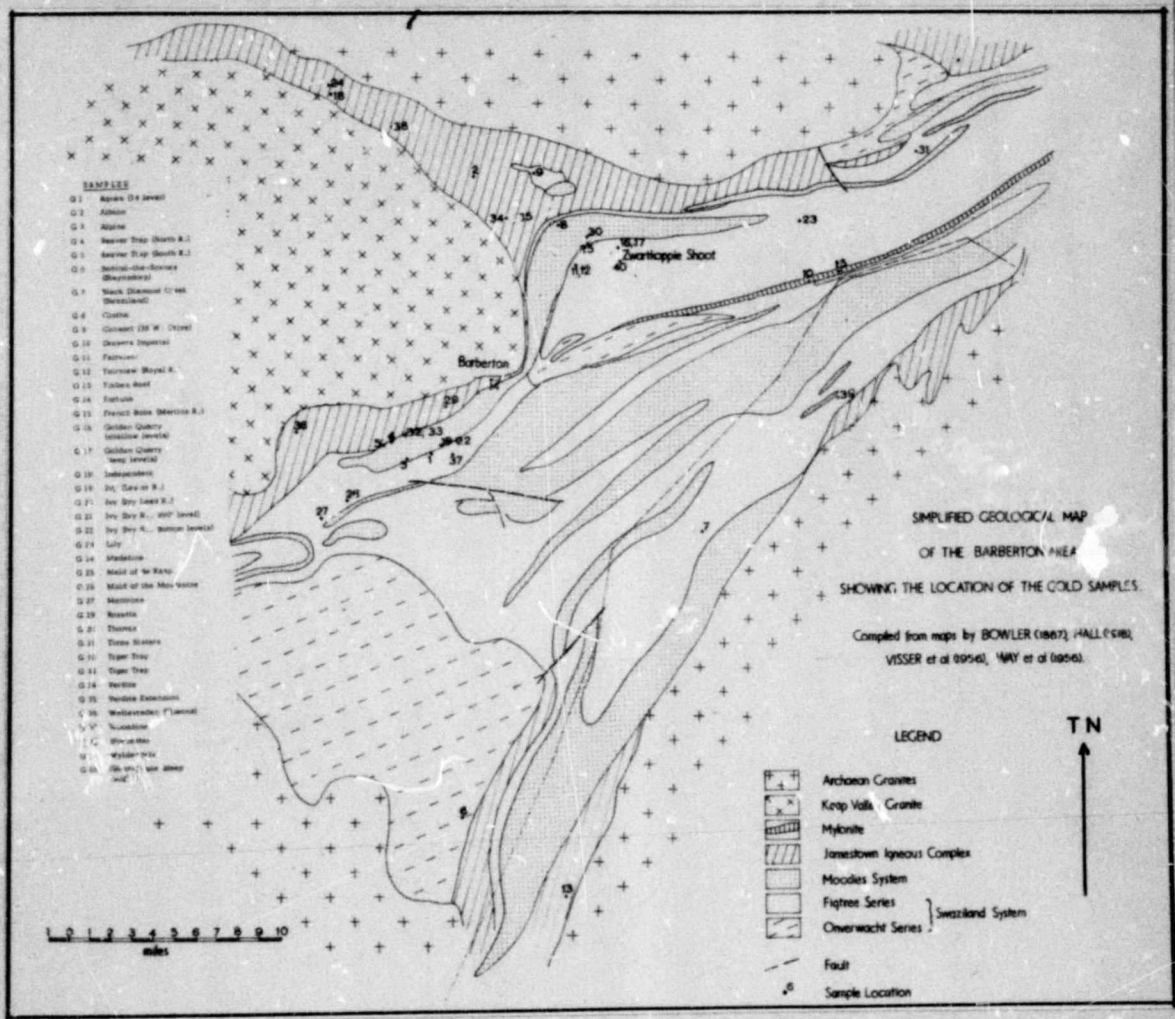


Figure 1 Simplified geological map of the Barberton District showing the approximate location of the gold samples.

Table V. The localities and nature of the individual G samples of native gold, with the types of analysis to which they were subjected.

Sample	Locality	Description of sample	Description of gold	Weight (mgm.)	Analysis
G 1	Agnes, 14 level	Chip sample; main associates pyrite and quartz	Fine grained, bright yellow to rich gold in colour; few grains with a brown coating.	33.1	A, B
G 2	Albion	Gold in quartz with covellite, chalcopyrite, chalcocite, and pyrite.	Fine to medium grained yellow colour	40.2	A, B, C.
G 3	Alpine	Chip sample; main associates Quartz, galena and pyrite.	Fine grained, yellow colour.	8.1	A.
G 4	Beaver Trap, North Reef	Chip sample; main associates quartz and pyrite.	Very fine grained, bright yellow in colour.	143.0	A, B, C.
G 5	Beaver Trap, South Reef.	Chip sample; main associates quartz and pyrite	Fine grained, yellow colour; some grains coated with iron oxide.	42.2	A, B, C.
G 6	Behind the Scenes, Steynsdorp	Chip sample.	Very fine grained, yellow colour.	23.2	A, C.
G 7	Black Diamond	Chip sample; main associates quartz, sericite, chlorite and pyrite.	Fine to coarse grained; coarse material rich gold in colour, finer material yellow to pale yellow.	85.6	A, B, C.
G 8	Clutha	Chip sample; main associates quartz, pyrite and magnetite.	Fine to coarse grained; fine grains yellow in colour, coarser ones gold	60.6	A, B, C
G 9	Consort, 38 West Drive.	Chip sample; main associates quartz, iron oxides and arsenopyrite.	Very fine grained; bright gold colour	110.5	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis; C - fire assay.

Table V, continued.

Sample	Locality	Description of sample	Description of gold	Weight (mgm)	Analysis
G 10	Dreyers Imperial	Chip sample; main associates quartz, magnetite, pyrite.	Fine to medium grained; yellow colour	198.6	A, B, C.
G 11	Fairview	Chip sample	Fine grained, yellow colour with a few, larger reddish grains.	8.1	A.
G 12	Fairview	Gold in grey quartz with pyrite and arsenopyrite	Medium grained, yellow colour	31.3	A, B.
G 13	Forbes Reef	Chip sample	Fine grained, yellow colour	9.1	A.
G 14	Fortuna	Chip sample, main associates pyrite, quartz, chalcopyrite and iron oxides.	Fine to medium grained; yellow to bright yellow colour.	45.1	A, B, C.
G 15	French Bobs Martins Reef	Chip sample	Fine grained, yellow colour.	20.5	A, C.
G 16	Golden Quarry, shallow levels.	Chip sample; main associates quartz, pyrite and arsenopyrite.	Fine grained, yellow colour.	101.4	A, B, C.
G 17	Golden Quarry, deep levels.	Chip sample; main associates quartz, arsenopyrite and pyrites.	Fine to medium grained; pale yellow to reddish colour.	68.2	A, B, C.
G 18	Independent	Chip sample; main associates pyrite, chalcopyrite, magnetite and quartz.	Fine to coarse grained; yellow to bright yellow colour.	62.0	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis;
C - fire assay.

Table V, continued.

Sample	Locality	Description of sample	Description of gold	Weight (mgm.)	Analysis
G 19	Ivy (Lester Reef)	Chip sample; main associates quartz and iron oxides.	Fine to medium grained; yellow to reddish colour	48.4	A, B, C.
G 20	Ivy (Ivy Lead Reef)	Chip sample.	Fine to medium grained, mainly yellow in colour with a few reddish grains.	37.8	A, B, C.
G 21	Ivy (Ivy Reef 900' level)	Chip sample; main associate pyrite.	Fine grained; yellow to bright yellow colour.	30.7	A, C.
G 22	Ivy (Ivy Reef bottom levels)	Chip sample; main associates quartz and pyrite.	Fine grained; bright yellow colour.	39.1	A, B, C.
G 23	Lily	Chip sample; main associates quartz, arsenopyrite and pyrite.	Fine to coarse grained; pale yellow to yellow.	109.5	A, B, C.
G 24	Madeline	Chip sample; main associates quartz, iron oxides, pyrite.	Fine to medium grained; pale yellow colour.	42.8	A, B, C.
G 25	Maid of de Kaap.	Chip sample.	Fine grained; yellow colour.	20.5	A, C.
G 26	Maid of the Mountains.	Chip sample; main associates quartz, pyrite, iron oxides.	Fine grained; yellow colour.	166.6	A, B, C.
G 27	Montrose	Chip sample	Fine to coarse grained; yellow colour.	112.4	A, B, C.
G 28	Olga	Chip sample	Fine grained; pale to bright yellow colour.	68.2	A, B, C.
G 29	Rosetta	Panned concentrate; main associates quartz, iron oxides, galena	Fine grained; mostly bright yellow colour with a few reddish grains.	63.5	A. B, C.

A - spectrographic analysis; B - atomic absorption analysis;
C - fire assay.

Table V, continued.

Sample	Locality	Description of Sample	Description of gold	Weight (mgm.)	Analysis
G 30	Thomas	Chip sample; main associates pyrite, quartz, iron oxides.	Fine to medium grained, bright yellow colour.	121.2	A, B, C.
G 31	Three Sisters	Chip sample.	Fine to medium grained; pale yellow colour.	37.1	A, C.
G 32	Tiger Trap	Chip sample; main associates magnetite, pyrite and quartz.	Fine to coarse grained; yellow colour with a few golden larger grains.	109.3	A, B, C.
G 33	Tiger Trap	Borehole core; main associates milky quartz, covellite, chalcocite and tennantite.	Medium grained; pale yellow colour.	21.3	A, C.
G 34	Verdite	Chip sample; main associates pyrite, iron oxides, quartz.	Fine to coarse grained; golden colour.	44.4	A, B, C.
G 35	Verdite Extension	Chip sample	Fine to medium grained; bright yellow colour.	40.4	A, B, C.
G 36	Weltevreden (Queens)	Chip sample; main associates pyrite and quartz.	Fine grained; bright yellow colour; few large grains golden in colour.	185.4	A, B, C.
G 37	Woodbine	Chip sample.	Fine to medium grained; golden colour.	124.0	A, B, C.
G 38	Worcester	Chip sample; main associates magnetite, quartz, pyrite.	Fine to coarse grained; yellow colour.	95.2	A, B, C.
G 39	Wyldesdale	Panned concentrate; main associates iron oxides, pyrite.	Fine grained; pale to bright yellow colour.	204.4	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis;
C - fire assay.

Table V, continued

Sample	Locality	Description of sample	Description of gold	Weight (mgm.)	Analysis
G 40	Zwartkopje, deep levels.	Chip sample.	Fine to coarse grained; bright yellow colour.	224.8	A, B, C.
G 41	Globe and Phoenix, Southern Rhodesia.	Chip sample; main associates pyrite, magnetite, quartz.	Very fine to coarse grained; golden colour.	210.6	A, B, C.
G 42	Selukwe, Southern Rhodesia	Chip sample; main associates magnetite, pyrite, quartz.	Fine to coarse grained; bright yellow colour.	91.5	A, B, C.
G 43	Cason Section, E.R.P.M.	Gold in banket.	Medium grained; golden colour.	56.1	A, B, C.
G 44	Market Square Johannesburg.	Gold in milky quartz.	Fine to medium grained; bright yellow colour.	73.0	A, B, C.
G 45	West Rand Consolidated G. M.	Disseminated gold in gritty quartzite.	Fine to medium grained; yellow to bright yellow colour.	154.4	A, B, C.
G 46	Angwa River Southern Rhodesia.	Nugget	Bright yellow to golden colour.	37.1	A, C.

A - spectrographic analysis; B - atomic absorption analysis;
C - fire assay.

N.B. Coarse grained - > 1.5 mm in diameter; medium grained - 0.5 - 1.5 mm in diameter; fine grained - < 0.5 mm in diameter.

Table VI. The localities and nature of the individual S samples of native gold, with the types of analysis to which they were subjected.

Sample	Locality	Description of sample	Description of gold	Weight (mgm)	Analysis
S 1	Zwartkopje shoot, 14 level, Z 1 stope	Free gold in green schist with quartz, pyrite, arsenopyrite and iron oxides.	Fine to medium grained; yellow colour; irregular grains with granular surface.	55.4	A, B, C.
S 2	Zwartkopje shoot, 14 level, Z 1 stope	Gold in green schist with pyrite, quartz and arsenopyrite.	Large, irregular grains; bright gold colour.	51.1	A, B, C.
S 3	Zwartkopje shoot, 14 level, C 4 stope.	Gold in milky and grey quartz with pyrite, arsenopyrite, and a little chalcopyrite.	Fine to very coarse grained; partly crystalline; yellow colour.	91.4	A, B, C.
S 4	Zwartkopje shoot, 17 level.	Gold in quartz-chlorite rock with pyrite and iron oxides.	Fine to medium grained; yellow colour; grains irregular or filiform in shape.	72.4	A, B, C.
S 5	Zwartkopje shoot, 17 level.	Gold in quartz-chlorite rock with pyrite and arsenopyrite.	Fine to medium grained; pale yellow colour.	10.2	A.
S 6	Zwartkopje shoot, 17 level.	Gold, pyrite and chalcopyrite in quartz.	Fine to medium grained; yellow colour.	7.7	A.
S 7	Zwartkopje shoot, 18 level.	Gold in milky quartz with pyrite and arsenopyrite.	Coarse grained; pale yellow colour.	112.8	A, B, C.
S 8	Zwartkopje shoot, 20 level, 20 Z 1 stope.	Gold, pyrite, iron oxides and arsenopyrite in quartz-chert breccia.	Fine grained; yellow colour; irregular grains with a granular surface.	28.8	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis;
C - fire assay.

Table VI, continued

Sample	Locality	Description of sample	Description of gold	Weight (mgm)	Analysis
S 9	Zwartkopje shoot, 20 level, 20 Z 1 stope.	Gold, pyrite, arsenopyrite iron oxide in quartz-chert breccia.	Fine grained; yellow colour; irregular grains with a granular surface.	20.1	A, B, C.
S 10	Zwartkopje shoot, 22 level.	Gold, pyrite, arsenopyrite, chalcopyrite and stibnite in quartz.	Fine to coarse grained; low colour.	71.4	A, B, C.
S 11	Zwartkopje shoot, 22 level.	Gold, pyrite, arsenopyrite, stibnite and a little chalcopyrite in quartz.	Very fine to coarse grained, yellow colour.	62.5	A, B, C.
S 12	Zwartkopje shoot, 22 level.	Gold, pyrite, arsenopyrite with a little stibnite and chalcopyrite in quartz.	Fine grained; yellow colour.	12.4	A.
S 13	Zwartkopje shoot, 23 level, sc[illegible]l stope.	Gold, pyrite, iron oxide and arsenopyrite in grey and white quartz.	Fine to coarse grained; yellow colour; grains irregular with some crystal faces.	110.4	A, B, C.
S 14	Zwartkopje shoot, 25 level.	Gold and pyrite in chert.	Fine to medium grained; yellow colour.	6.1	A.
S 15	Zwartkopje shoot, 25 level.	Gold, pyrite, arsenopyrite and a little chalcopyrite in green schist.	Fine to medium grained; yellow colour; some grains crystalline.	101.9	A, B, C.
S 16	Zwartkopje shoot, 25 level.	Gold, pyrite, arsenopyrite and chalcopyrite in green schist.	Medium grained; yellow colour; most grains irregular with few crystal faces.	94.5	A, B, C.
S 17	Zwartkopje shoot, 26 level drive east.	Gold, pyrite, arsenopyrite, iron oxide in chert.	Medium to coarse grained; pale yellow colour.	77.1	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis; C - fire assay.

Table VI, continued.

Sample	Locality	Description of Sample	Description of gold	Weight (mgm.)	Analysis
S 18	Zwartkopje shoot, 26 level.	Gold and pyrite in chert.	Medium grained; pale yellow colour; filiform and aborescent grains mostly.	24.0	A, C.
S 19	Zwartkopje shoot, 26 level.	Gold, arsenopyrite, pyrite in chert.	Medium grained, yellow colour.	57.8	A, B, C.
S 20	Zwartkopje shoot 25 level.	Gold, pyrite, arsenopyrite in chert and chalcopyrite.	Medium to coarse grained; yellow colour; irregular grains with granular surface.	128.4	A, B, C.
S 21	Birthday pipe, 24 level, Birthday winze.	Gold, pyrite and chalcopyrite in milky quartz.	Fine to coarse grained; yellow colour.	74.0	A, B, C.
S 22	Birthday pipe, 24 level, Birthday winze.	Gold, pyrite, iron oxide and graphite in quartz.	Medium grained; yellow colour.	55.0	A, B, C.

A - spectrographic analysis; B - atomic absorption analysis
C - fire assay.

N.B. Coarse grained - 1.5 mm
Medium grained - 0.5 - 1.5 mm
Fine grained - 0.5 mm

shown by Eales (1961) that the fineness of native gold varies markedly from one particle to another over distances of a few hundred microns. Therefore, single samples of visible gold may not be representative of the area from which they are taken. However, many of the samples in the G series were collected some years ago from mines no longer in existence and therefore additional samples could not be obtained. In addition, in a blind survey such as this, random samples taken over a whole region may be statistically representative. The S series of samples were collected as systematically as possible to allow for changing physical conditions of deposition. Unfortunately, the sporadic occurrence of grains of native gold did not allow for a more complete coverage of the shoot.

(b) Ore microscopic examination of native gold

Polished sections of gold samples from the Barberton district were examined with a view to establishing the relationship between gold and the associated minerals. However, it was not possible to examine the actual samples analyzed because of the limited amount of material available in each sample (see tables V and VI), all of which was required for the analytical procedures. The specimens examined were, however, taken from the same deposits and are assumed to illustrate the general relationship, in the Barberton district, of gold and the associated ore minerals.

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In all the specimens examined, visible gold seemed to be late in the paragenetic sequence. It, therefore, occurred mainly in irregular grains and flakes which enclosed the adjacent gangue and ore minerals. Veins of gold were also observed to fill in cracks in the associated minerals. The size of the individual grains varied from a few microns to 1.5 mm or more. The smaller grains tended to occur as irregular flakes enclosed in the sulphides and quartz, whereas the larger grains completely enveloped the surrounding minerals. This relationship between the larger grains and the associated minerals was substantiated during the extraction of the gold by dissolution of the samples in hydrofluoric acid, when it was found that the larger gold grains released in this way, were riddled with small particles of quartz and sulphide minerals. Sulphide particles were even found in the centre of what seemed to be solid grains of gold.

Furthermore, it was found in polished sections, that minute inclusions were very common indeed in gold grains of all sizes. These inclusions occurred either on the grain boundaries or in the actual crystals themselves. In some specimens, the inclusions were regularly spaced parallel to the cleavage directions of the gold. They were normally too small to be identified but occasionally were recognizable as quartz, pyrite or chalcopyrite.

Therefore, it is seen that generally native gold from Barberton

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