Dissolution: fieldtrip techniques

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September 22, 2016

Rough schedule

- Day 1: En route: Sourcing any materials, maps and guides, saltpeter from any stables! Plan Day 2 sites.
- Day 2: Visit local guides/mineral centres for advice. Reconnaitre local sites and collect first samples (ores, earth, water). Start processing.
- Day 3: Visit further afield sites. Collection of all samples and complete processing. Making charcoal. Photographic and logic processes.
- Day 4: Furnace experiment, distillation experiments in identified site
- Day 5: Return to Montreal.

Materials/to bring/source

Materials for photographic processing/Collodion

Extraction/processing - rock hammers, maybe basic hammers, small trowels, pestle and mortar

Furnace - concrete mix, clay

Thermite - sparklers, aluminium powder, sulphur

Salt water, salt, potassium nitrate, ammonium chloride, hydrochloric acid

Misc: aluminium foil, magnets, plastic tubing (to fit distillation) and plastic funnels

Glassware for distillations

Fire bricks

PH paper for testing, water bottles and containers for samples, micro-scales, coffee filters

Goggles, gloves, gardening gloves, knives, general tools

MAPP gas torch

Sites

From: Rocks and minerals for the collector: Kirkland Lake - Rouyn-Noranda - Val-d'Or, Ontario and Quebec

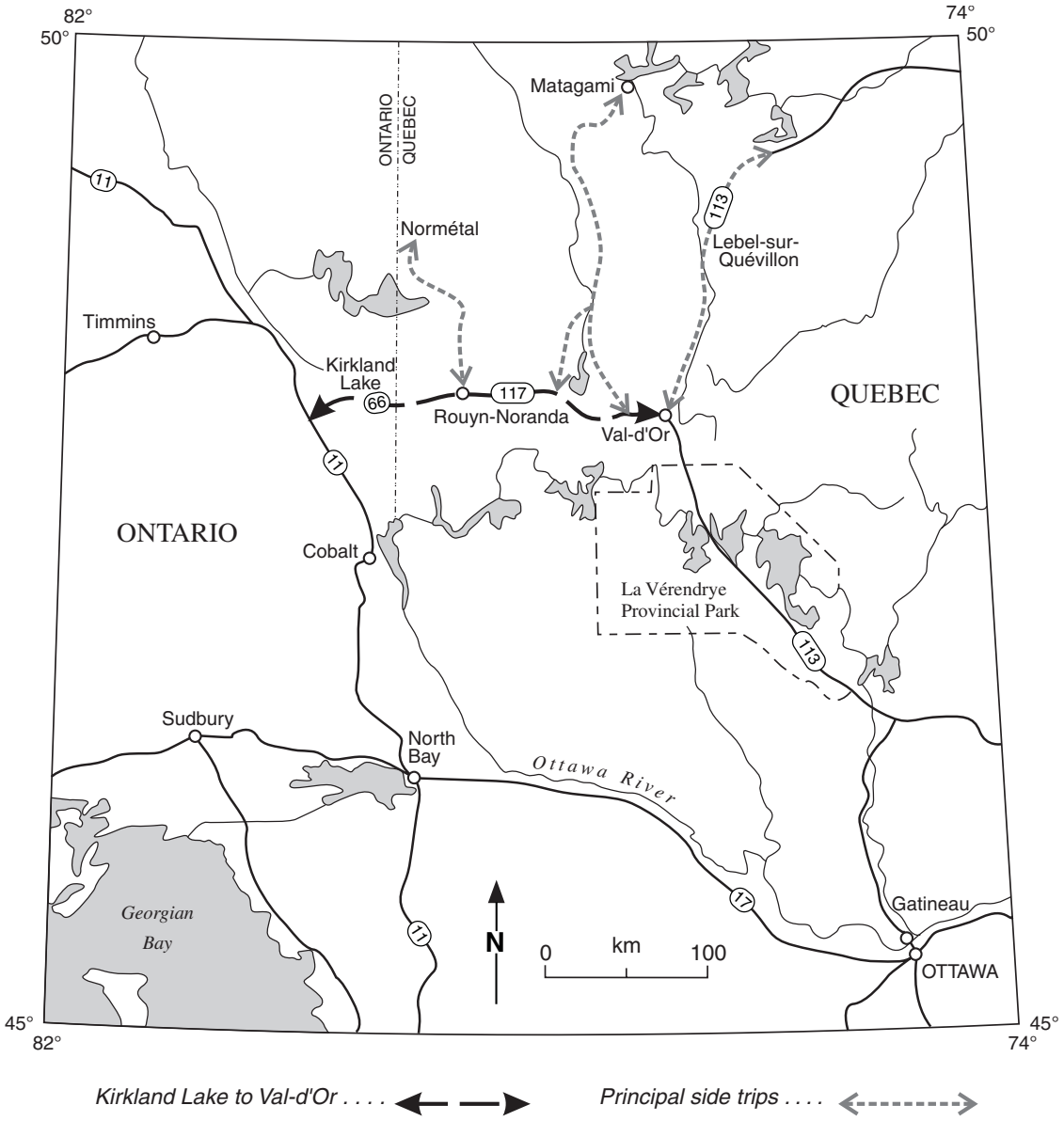


Figure 1. Map showing the collecting route.

section); references to maps of the National Topographic System (T) and to geological maps (G) of the Geological Survey of Canada (GSC), the Ontario Geological Survey (OGS), and Quebec's ministère des Ressources naturelles (MRNQ).

UNITS OF MEASUREMENT

Units of measurement obtained from publications referred to in the text have been converted from the Imperial system to the International System (SI). The following conversions were used:

1 inch = 2.54 cm	1 ounce (Troy) = 31.103 g
1 foot = 0.305 m	1 ton (short) = 0.907 t
1 mile = 1.609 km	1 pound (avoirdupois) = 0.453 kg
1 acre = 0.40469 ha	1 oz (Troy)/ton(short) = 34.285 g/t

km	**77.7**	Junction, Highway 101. Collecting localities in the Belleterre area may be reached via Highway 101; they are described in *Rocks and Minerals for the Collector: Cobalt–Belleterre–Timmins, Ontario and Quebec* (GSC Miscellaneous Report 57).
km	**79.9**	Arntfield, junction of the road leading north to the Arntfield mine (p. 55), the Francoeur (Wasamac No. 2) mine (p. 55), and the Robb-Montbray mine (p. 56).
km	**81.7**	Junction, road on left leading north to a gravel pit and to the Aldermac mine (p. 57).
km	**83.6**	Junction, road leading northwest to the Aldermac mine (p. 57).
km	**84.2**	Junction, road leading east to the Wasa Lake (Wasamac No. 1) mine (p. 58) and the Wingait mine (p. 59).
km	**91.1**	Évain, junction of a road leading north to the Elder (Peel-Elder) mine (p. 60), the Quesabe mine (p. 61), and the Eldrich (Pierre Beauchemin) mine (p. 62), and a road leading south to the Durbar (Huronian Belt) mine (p. 63), the Riverside (Bazooka) mine (p. 65), and the Canada Black Granite quarry (p. 65).
km	**96.9**	Junction, Highway 101 north. Highway 101 north provides access to the Don Rouyn mine (p. 69), the Silidor mine (p. 69), the Powell Rouyn mine (p. 70), the Pontiac Rouyn (Anglo Rouyn) mine (p. 71), the Marlon Rouyn (New Marlon) mine (p. 72), the Quemont mine (p. 72), the Joliet mine (p. 73), the Donalda (Kerralda) mine (p. 74), the D'Eldona (Delbridge) mine (p. 75), the MacDonald (Gallen) mine (p. 75), the Millenbach mine (p. 76), the Amulet mine (p. 77), the Corbet mine (p. 78), the Norbec (Lake Dufault) mine (p. 78), the Waite-Ackerman-Montgomery (Old Waite) mine (p. 79), the Vauze mine (p. 80), the Ansil mine (p. 81), the Fabie Bay (New Insco) mine (p. 81), the Newbec mine (p. 82), the Mobrun (Bouchard-Hébert) mine (p. 83), the Harvie (Archean) mine (p. 83), the LeRoy (Roybell, Claremont) mine (p. 84), the Vezina (Thurbois) mine (p. 85), the Duquesne mine (p. 86), the Central Duparquet mine (p. 87), the Beattie-Donchester mine (p. 87), the Roquemaure jasper occurrence (p. 89), the Hunter mine (p. 90), the Lyndhurst mine (p. 91), the Duvan mine (p. 92), the Normetal (Abana) mine (p. 92), and the Casa-Berardi (Golden Pond) mines (p. 94).
km	**98.1**	Rouyn-Noranda, junction of Highway 117 (Rideau Boulevard) and Richelieu Street leading east to Mouska Park and the Chadbourne mine (p. 95).
km	**98.4**	Rouyn-Noranda, junction of Highway 117 (Rideau Boulevard) and Senator Road leading west to the Senator Rouyn mine (p. 96).
km	**99.1**	Rouyn-Noranda, junction of Highway 117 (Rideau Boulevard) and Québec Boulevard leading south. Québec Boulevard provides access to the Abbeville mine (p. 98), the Stadacona mine (p. 98), the Astoria mine (p. 99), and the Granada mine (p. 100).
km	**109.5**	Junction, road leading south to McWatters and to the McWatters mine (p. 101) and the Adanac mine (p. 102).
km	**111.6**	Junction, road leading north to the Rouyn-Merger mine (p. 104).

km	**119.7**	Junction, road leading north to the Heva mine (p. 104).
km	**123.2**	Junction, road leading north to the Hosco mine (p. 105).
km	**129.3**	Junction, road leading north to the Arrowhead mine (p. 105).
km	**133.2**	Junction, trail leading south to the Calder-Bousquet mine (p. 106).
km	**135.2**	Junction, road leading north to Saint-Norbert-de-Mont-Brun and to the Doyon (Silverstack) mine (p. 106), the Mooshla mine (p. 108), and the Mouska (Mic Mac) mine (p. 109).
km	**135.9**	Junction, road leading south to the Norgold and Doreva mines (p. 110).
km	**146.0**	Bouscadillac mine (p. 111), on the north side of Highway 117.
km	**146.1**	Junction, Highway 395. Highway 395 provides access to the LaRonde (Dumagami) mine (p. 111), the Bousquet No. 1 and Bousquet No. 2 mines (p. 113), the Cadillac Moly (Anglo American) mine (p. 114), the Preissac (Indian) mine (p. 116), and the Height of Land mine (p. 117).
km	**147.7**	Thompson Cadillac mine (p. 118), on the north side of Highway 117.
km	**149.4**	Junction, road leading north to the O'Brien mine (p. 120).
km	**150.0**	Cadillac, junction of a road leading north to the Kewagama mine (p. 120).
km	**152.6**	Junction, road leading north to the Central Cadillac and Wood Cadillac mines (p. 121).
km	**154.3**	Pandora (Amm) mine (p. 122), on the south side of Highway 117.
km	**155.7**	Junction, road leading south to the Pandora (Amm) mine (p. 122).
km	**156.9**	Pandora (Amm) mine (p. 122), on the north side of Highway 117.
km	**157.5**	Tonawanda mine (p. 123), on the north side of Highway 117.
km	**159.0**	Junction, trail leading south to the Lapa Cadillac mine (p. 123).
km	**163.4**	Rivière-Héva, junction of Highway 109. Highway 109 provides access to the Moly Hill mine (p. 124), the Marbridge mine (p. 126), the La Motte (Authier, Colombe) lithium occurrence (p. 127), the Jay (Amos) mine (p. 128), the Nortrac mine (p. 130), the Fontana mine (p. 130), the Claverny mine (p. 131), the Duvay mine (p. 132), the Goldvue mine (p. 133), the Trinity mine (p. 134), the Sleeping Giant mine (p. 134), the Abitibi Asbestos mine (p. 135), the Eagle (Agnico-Eagle) mine (p. 136), the Joutel Copper mine (p. 136), the Mines de Poirier mine (p. 138), the Selbaie (Detour) mine (p. 139), the Orchan mine (p. 140), the Bell Allard mine (p. 141), the Mattagami Lake mine (p. 143), the Isle-Dieu mine (p. 144), the New Hosco mine (p. 145), the Norita mine (p. 146), the Garon Lake mine (p. 147), and the Radiore No. 2 mine (p. 148).
km	**168.1**	Junction, road leading south to the West Malartic mine (p. 148).
km	**179.4**	Malartic, junction of Highway 117 and Abitibi Avenue leading south to the Canadian Malartic mine (p. 149).
km	**181.2**	Junction, road leading south to the Sladen Malartic mine (p. 151) and a road leading north to the Barnat mine (p. 152).

and discovered significant tungsten mineralization. Because of the demand for tungsten, the company deepened the shaft to 98 m in 1951–1952 and conducted a program of drilling followed by geophysical surveys in 1956 and 1957. In 1972–1973, Somed Mines Limited dewatered the shaft and drove a decline 140 m toward the shaft. El Coco Explorations Limited continued underground development between 1979 and 1984, extending the decline to a total length of 909 m to the 152 m level. The company shipped 15 297 t of ore averaging 2.44 g/t gold to the Lamaque and Belmoral mills near Val-d'Or. The sample produced 14 152 g of gold.

The mine is about 42 km northeast of Kirkland Lake and 35 km west of Rouyn-Noranda. It is near the northeastern end of Labyrinth Lake. *See* Map 7 on page 49.

Road log from Highway 66 at **km 55.1** (*see* p. 7):

km		
	0	Junction, Highway 66 and the road to Cheminis; proceed north along the road to Cheminis.
	4.0	Junction; continue straight ahead (northeast).
	8.8	Junction; turn right (east).
	19.2	Russian Kid (Bordulac) mine.

Refs.: 61 p. 19–20; 65 p. 234–235; 143 p. 87; 271 p. 12; 425 p. 25; 431 p. 34.

Maps (T): 32 D/4 Larder Lake
(G): 50-3A Northwest Dasserat, Témiscamingue County, Quebec (GSC, 1:12 000)
271A Rouyn-Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

ROUYN-NORANDA–VAL-D'OR AREA

The mineral deposits along Highway 117 lie within the gold-producing belt of early Precambrian volcanic and sedimentary rocks extending eastward from Timmins through Kirkland Lake to and beyond Val-d'Or; they contain numerous gold-copper and copper-zinc-gold deposits. Outside this mineralized belt, the region contains deposits of molybdenum, bismuth, lithium, and beryl associated with granitic batholiths and deposits of nickel in ultrabasic rocks. Many of the early producers are now inactive.

It was the search for precious metals that initiated prospecting in the area. The early discoveries of gold mineralization were made in 1906 at Fortune Lake, in 1910 at Cadillac and Duparquet Lake, and in 1911 at Lac de Montigny. Because the attention of prospectors and developers was focused at that time on the exciting discoveries in the Porcupine district, the Rouyn-Noranda–Val-d'Or area did not undergo extensive prospecting until 1923–1924 after Ed Horne staked his discovery that became the Horne mine. During that prospecting rush, the entire Rouyn-Noranda area was staked, numerous discoveries of gold and copper-gold showings were made, and claims staked several years earlier were re-examined. Production increased successively each year from 1928 until 1942 when 32 mines in the western Quebec area accounted for the bulk of the province's output of slightly over 31 000 000 g of gold. The 1939 production of 29 600 kg from western Quebec gold mines placed the province in second position after Ontario in Canada's gold production, a position it holds today. Thirteen gold mines and seven base-metal mines operated in the Rouyn-Noranda–Val-d'Or area in 1997.

Descriptions are given for mines and occurrences accessible from Highway 117.

Refs.: 3 p. 6–8; 28; 74 p. 1–5; 85; 158 p. 126–144; 177 p. 10; 181 p. 204–206; 249 p. 15; 250 p. 28; 274 p. 4–52; 283 p. 93–105; 287 p. 10, 55; 367.

Maps (T): 32 C Senneterre
32 D Noranda-Rouyn
(G): 1600-V Metallic mineralization in Noranda, Matagami, Val d'Or, and Chibougamau areas (MRNQ, 1:253 440)

Lake Fortune mine

NATIVE GOLD, PYRITE, CHALCOPYRITE, SYLVANITE, PETZITE, CHROME MUSCOVITE

In shear zone in lava

Native gold occurs in quartz, and associated with pyrite, chalcopyrite, and the telluride minerals sylvanite and petzite in quartz-ankerite veins in chlorite-sericite schist. The quartz-carbonate veins contain green chrome muscovite (fuschite).

Alphonse Olier and Auguste Renaud of Ville-Marie, Quebec, discovered the deposit in 1906, the first discovery of gold mineralization in northwestern Quebec. In 1907, the discoverers formed Pontiac and Abitibi Mining Company, which excavated some pits. Underground investigation began in 1910–1911 when Union Abitibi Mining Company sank No. 1 shaft to 43 m. Towagmac Exploration Company Limited continued exploration in 1923–1933 and sank No. 2 shaft to 46 m. Lake Fortune Gold Mines Limited sank No. 3 shaft to 149 m in 1934–1935. The underground operations exposed some spectacular native gold and gold tellurides, but ore of consistent commercial grade was not located. Some gold was obtained by panning the sand. Ressources Minières Rouyn Inc. (name changed in 1988 to 'Rouyn Mining Resources Inc.' and in 1991 to 'Richmont Mines Inc.') conducted underground exploration via a ramp to the 108 m level in 1985.

The mine is about 20 km southwest of Rouyn-Noranda and 3 km west of Arntfield. *See* Map 8 on page 54.

Road log from Highway 117 at **km 74.2** (*see* p. 7):

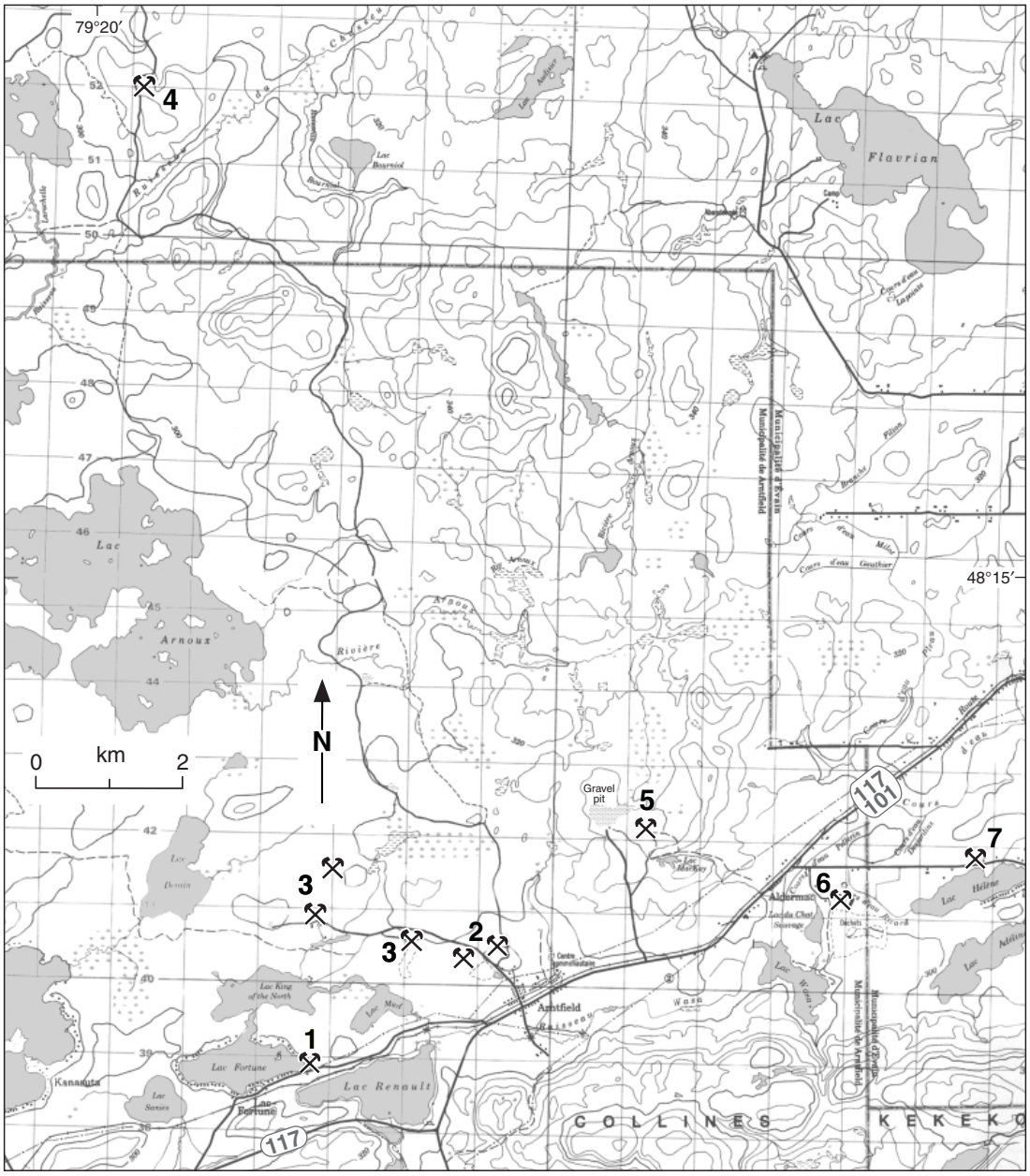
km		
	0	Junction, road to Lac-Fortune; proceed north along the road to Lac-Fortune.
	1.3	Junction, at Lac-Fortune; continue straight ahead along the road leading east.
	2.15	Lake Fortune shaft No. 2 on left (between the road and the shore of Fortune Lake); continue straight ahead to reach the other shafts.
	2.3	Junction. Follow the road on left leading north 300 m to shaft No. 3; continue straight ahead (east) 125 m to shaft No. 1 on the right (south) side of the road.

Refs.: 45 p. 39, 59–64; 65 p. 262–263; 83 p. 132–133; 204 p. 19–21; 272 p. 14; 452 p. 348; 458 p. 343.

Maps (T): 32 D/3 Rouyn
(G): 45-17A Western Beauchastel, Témiscamingue County, Quebec (GSC, 1:12 000)
218 Arntfield-Aldermac mines area, Township of Beauchastel (co. Témiscamingue) (MRNQ, 1:12 000)
271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)

463 Fortune Lake area, Dasserat Township, Témiscamingue County (MRNQ, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Part of 31 D/3, 6



1. Lake Fortune mine 2. Arntfield mine 3. Francoeur (Wasamac No. 2) mine
4. Robb-Montbray mine 5. Aldermac mine 6. Wasa Lake (Wasamac No. 1) mine
7. Wingait mine

Map 8. Arntfield

Arntfield mine

NATIVE GOLD, PYRITE, HEMATITE, RUTILE, CHALCOPYRITE, EPIDOTE, TOURMALINE, CHLORITE, TALC, ORTHOCLASE

In sheared volcanic rocks, diorite, and quartz-feldspar porphyry

Native gold was associated with pyrite in quartz and in albite-carbonate veins. Hematite, rutile, and chalcopyrite occurred in massive pyrite. The dumps furnish specimens of epidote and black tourmaline in quartz, dark green chlorite associated with yellowish-green talc, grey mica, pyrite, and specular hematite in a quartz-carbonate matrix, pink granular massive calcite, and brick-red massive orthoclase.

F.S. Arntfield staked the original claim during the Rouyn prospecting rush in the autumn of 1923. Arntfield Gold Mines Limited began development of the original claim and the adjacent claims in 1929. Production began in 1935 and ended in 1942. The mine produced 480 238 t of ore, which yielded 1 731 255 g of gold and 453 637 g of silver, valued at $2 011 755. The mine workings consisted of three shafts, 76 m, 328 m, and 305 m deep. A mill at the mine site operated at a capacity of 317 t/day.

The mine is about 18 km west of Rouyn-Noranda and 1 km northwest of Arntfield. *See* Map 8 on page 54.

Road log from Highway 117 at **km 79.9** (*see* p. 8):

km		
	0	Junction, in Arntfield; proceed along the road leading north.
	0.3	Junction; follow the road on left leading northwest.
	0.9	Intersection; the road on right leads 380 m northeast to the Arntfield main shaft and the site of the mill. The road on left leads 150 m southwest to another shaft. The road log continues straight ahead (west).
	1.3	Old Arntfield shaft and small dump on the left (south) side of the road.

Refs.: 5 p. 22–23; 45 p. 64–73; 65 p. 270–275; 83 p. 132–134, 134–135; 131 p. 711–716; 132 p. 485–486; 271 p. 20; 402 p. 63; 405 p. 65; 421 p. 214.

Maps (T): 32 D/3 Rouyn
(G): 45-17A Western Beauchastel, Témiscamingue County, Quebec (GSC, 1:12 000)
218 Arntfield–Aldermac mines area, Township of Beauchastel (co. Témiscamingue) (MRNQ, 1:12 000)
271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
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M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Francoeur (Wasamac No. 2) mine

NATIVE GOLD, PYRITE, HEMATITE, RUTILE, CHALCOPYRITE, MELONITE, GYPSUM, ANHYDRITE

In sheared volcanic rocks, diorite, and quartz-feldspar porphyry

Native gold occurs as grains in pyrite and as fine disseminations in albite-carbonate veins. Hematite, rutile, chalcopyrite, and melonite occur in massive pyrite. Minerals in the shear zone include gypsum, anhydrite, hematite, muscovite, and carbonates. The deposit is similar to the Arntfield gold deposit and is in the western end of the Francoeur-Arntfield zone of gold-bearing sheared rocks.

The original property consisted of the Francoeur-Thomson claims staked in 1923. Exploration in 1926–1929 by Towagmac Exploration Company Limited outlined the eastern (No. 1) orebody 300 m west of the Arntfield mine. In 1936, Francoeur Gold Mines Limited discovered two more orebodies, No. 2 orebody, 550 m west of No. 1, and No. 3 orebody, 1170 m west of No. 1. The company mined the deposit from two inclined shafts 610 m apart (No. 1 shaft to 227 m and No. 2 shaft to 172 m). Production from 1938 to 1947 yielded 2 880 200 g of gold from 517 632 t of ore. Between 1967 and 1971, Wright-Hargreaves Mines Limited sank the Wasamac No. 2 shaft to 476 m on No. 3 orebody and recovered 2 173 260 g of gold from 385 652 t of ore, which were processed at the Wasamac mill at the Wasa Lake mine. In 1985, Ressources Minières Rouyn Inc. (name changed in 1988 to 'Rouyn Mining Resources Inc.') acquired the Francoeur property and discovered a new orebody 760 m northeast of No. 3 orebody. In 1991, Richmont Mines Inc. began production from the new orebody via the 823 m Jean Rivard shaft. The mine has been in production since 1988.

The mine is about 20 km west of Rouyn-Noranda and 2 km northwest of Arntfield. *See* Map 8 on page 54.

Road log from Highway 117 at **km 79.9** (*see* p. 8):

km		
	0	Junction, in Arntfield; proceed along the road leading north.
	0.3	Junction; follow the road on left.
	0.9	Junction, road to the Arntfield mine; continue straight ahead.
	1.7	Francoeur (Wasamac No. 2) mine. The old shafts are on the south side of the road. The road continues west to the main operations.

Refs.: 5 p. 22–23; 45 p. 64–73; 65 p. 270–275; 72 p. 35–54; 73 p. 1664–1672; 83 p. 132–134, 134–135; 131 p. 711–716; 132 p. 485–486; 204 p. 24–26; 271 p. 20; 272 p. 14; 276 p. 11; 402 p. 63; 405 p. 65; 417 p. 64–65; 421 p. 214; 422 p. 80; 441 p. 371; 456 p. 402; 457 p. 343; 459 p. 310.

Maps (T): 32 D/3 Rouyn
(G): 45-17A Western Beauchastel, Témiscamingue County, Quebec (GSC, 1:12 000)
218 Arntfield–Aldermac mines area, Township of Beauchastel (co. Témiscamingue) (MRNQ, 1:12 000)
271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Robb-Montbray mine

CHALCOPYRITE, PYRITE, PYRRHOTITE, SPHALERITE, CHALCOCITE, NATIVE GOLD, ALTAITE, TELLUROBISMUTHITE, KRENNERITE, PETZITE, COLORADOITE, MELONITE, FROHBERGITE, MONTBRAYITE

In altered rhyolite

Chalcopyrite occurred as a replacement of chlorite in silicified and chloritized rhyolite. Pyrite, pyrrhotite, sphalerite, and chalcocite were minor constituents of the ore. Native gold occurred with microscopic intergrowths of the telluride minerals, altaite, tellurobismuthite, krennerite, petzite, coloradoite, melonite, frohbergite, and montbrayite. A pocket containing 5 kg of massive gold and gold tellurides was found during underground exploration. The deposit contained two new mineral species, frohbergite and montbrayite. Frohbergite occurred as microscopic patches in intergrowths of other telluride minerals; it was named in honour of mining geologist Dr. M.H. Frohberg of Toronto, Ontario. Montbrayite, named for the mine and the township in which it occurs, was found as coarsely crystallized aggregates with other telluride minerals.

J.M. Robb discovered and staked the property for Quebec Prospectors Limited in 1924. Nipissing Mines Company Limited explored the deposit from 1925 to 1929 and sank a shaft to 172 m. In 1934–1935, Robb-Montbray Mines Limited investigated the deposit and shipped 1106 t of copper-zinc-silver-gold ore to the Noranda smelter. Between 1958 and 1962, Inmont Copper Mines Limited installed a new headframe and conducted an underground investigation.

The mine is about 25 km northwest of Rouyn-Noranda and 14 km northwest of Arntfield. *See* Map 8 on page 54.

Road log from Highway 117 at **km 79.9** (*see* p. 8):

km		
	0	Junction, in Arntfield; proceed along the road leading north.
	0.3	Junction; follow the road on right leading northeast.
	7.0	Junction, road on left; continue straight ahead (east).
	17.6	Robb-Montbray mine.

Refs.: 65 p. 224–227; 83 p. 112–113; 145 p. 27–28; 332 p. 86; 337 p. 346, 352, 359, 360, 364, 368, 369, 380; 339 p. 11–14; 434 p. 115.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
1535 Southeast quarter of Montbray Township, Rouyn-Noranda County (MRNQ, 1:12 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Aldermac mine

PYRITE, MAGNETITE, PYRRHOTITE, CHALCOPYRITE, SPHALERITE, CHLORITOID, TREMOLITE, EPIDOTE, HORNBLENDE, DEVILLINE, BROCHANTITE, GYPSUM, GOETHITE

In rhyolite, tuff, and agglomerate

The ore consisted of massive pyrite and pyrrhotite with smaller amounts of magnetite, chalcopyrite, and sphalerite. Quartz, calcite, epidote, chlorite, titanite, and amphibole were associated with the ore minerals. Chloritoid was found in magnetite. Tremolite occurred as a replacement of quartz and chlorite. The rock dumps furnish specimens of epidote and black tourmaline in quartz, and secondary minerals including greenish-blue devilline, bright green brochantite, white gypsum, and rusty brown goethite occurring as coatings and encrustations on ore

specimens. A buff-coloured porphyritic rhyolite suitable for lapidary purposes occurs at the mine; it is composed of lath-shaped oligoclase feldspar in a fine-grained matrix of feldspar, quartz, and sericite. Fragments of this rock are found in gravel pits in the vicinity of the mine.

The mine is a former producer of copper, gold, silver, and sulphur. A.A. MacKay and W.P. Alderson staked the deposit in the winter of 1923. In 1926, Towagmac Exploration Company Limited located an economic orebody by drilling and underground exploration. Aldermac Mines Limited undertook development of the deposit in 1927 and operated a concentrating mill in 1932 to produce copper and pyrite concentrates. From 1937 to 1943, Aldermac Copper Corporation Limited worked the deposit from a shaft 496 m deep. The mine produced 28 041 t of copper, 332 024 g of gold, 12 102 177 g of silver, and 518 296 t of pyrite concentrates.

The mine is about 13 km west of Rouyn-Noranda and 3 km northeast of Arntfield. It is just east of a large gravel pit. *See* Map 8 on p 54.

Road log from Highway 117 at **km 81.7** (*see* p. 8):

km		
	0	Junction, road leading to a gravel pit; proceed north along this road. A small rock dump and the site of the filter plant are on the north side of Highway 117 at this junction.
	0.9	Junction; turn right (east).
	1.5	Junction; continue straight ahead (northeast).
	1.9	Aldermac mine.

An alternate route is via a 2 km road leading northwest from Highway 117 at **km 83.6**.

Refs.: 5 p. 21; 13 p. 44; 45 p. 74–86; 53 p. 1–5; 65 p. 175–183; 139 p. 719–725; 150 p. 131–135.

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M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Wasa Lake (Wasamac No. 1) mine

NATIVE GOLD, PYRITE, CHALCOPYRITE, CHROME MUSCOVITE, HEMATITE, EPIDOTE

In sheared volcanic rocks

Gold-bearing pyrite occurred in quartz, carbonate, and chlorite. Chrome muscovite (fuchsite), epidote, and hematite were less common, and visible gold was very rare.

La Mine d'Or Champlain Limited discovered gold on this property in 1936 and explored the deposit via a 67 m shaft. Between 1944 and 1950, Wasa Lake Gold Mines Limited located a gold-bearing shear zone and sank a shaft to 385 m. Wasamac Mines Limited extended the

underground workings to 412 m and began production in 1965. A mill, brought in from the Bicroft mine in the Bancroft, Ontario area, operated until the mine closed in 1971. The mine produced 7 906 538 g of gold and 136 291 g of silver.

The mine is about 13 km southwest of Rouyn-Noranda and 4 km northeast of Arntfield. *See* Map 8 on page 54.

Road log from Highway 117 at **km 84.2** (*see* p. 8):

km		
	0	Junction; proceed east along the road toward Hélène Lake.
	0.3	Turn right (south) onto the mine road.
	1.0	Wasa Lake (Wasamac No. 1) mine.

Refs.: 5 p. 23–21; 113 p. 730–733; 399 p. 47; 425 p. 110; 440 p. 343–344; 443 p. 396–397.

Maps (T): 32 D/3 Rouyn
(G): 45-17A Western Beauchastel, Témiscamingue County, Quebec (GSC, 1:12 000)
218 Arntfield–Aldermac mines area, Township of Beauchastel (co. Témiscamingue) (MRNQ, 1:12 000)
271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
464 Wasa Lake area, Beauchastel Township, Témiscamingue County (MRNQ, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Wingait mine

NATIVE GOLD, PYRITE, CHLORITE

In rhyolite

Native gold and pyrite occur in a carbonate-quartz zone in sheared rhyolite. Chlorite is also present.

Wingait Gold Mines Limited located a gold-bearing zone during exploration from 1944 to 1947. Development consisted of a 10 m shaft.

The mine is about 11 km west of Rouyn-Noranda and 6 km northeast of Arntfield. It is just north of Hélène Lake. *See* Map 8 on page 54.

Road log from Highway 117 at **km 84.2** (*see* p. 8):

km		
	0	Junction; proceed east along the road toward Hélène Lake.
	0.3	Turnoff to the Wasa Lake (Wasamac No. 1) mine; continue straight ahead.
	2.4	Wingait mine on left, about 120 m north of the road.

Refs.: 155 p. 19–20; 399 p. 48.

Maps (T): 32 D/3 Rouyn
(G): 45-17A Western Beauchastel, Témiscamingue County, Quebec (GSC, 1:12 000)

218 Arntfield–Aldermac mines area, Township of Beauchastel (co. Témiscamingue) (MRNQ, 1:12 000)
271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
464 Wasa Lake area, Beauchastel Township, Témiscamingue County (MRNQ, 1:9600)
1106A Southeast Beauchastel Township, Témiscamingue County, Quebec (GSC, 1:18 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Elder (Peel-Elder) mine

NATIVE GOLD, PYRITE, HEMATITE, CHALCOPYRITE, GALENA, MOLYBDENITE, QUARTZ CRYSTALS

In granite

The ore consisted of pyrite with minor amounts of specular hematite, chalcopyrite, galena, and molybdenite in quartz veins. Native gold occurred in fractures in bluish cherty quartz. The mine dumps furnish specimens of massive quartz containing cavities lined with crystals of quartz and pyrite.

O'Leary Malartic Mines Limited discovered a gold-bearing zone during surface exploration in 1933. In 1944, Elder Gold Mines Limited began an extensive program of drilling followed by underground development. Mining from 1946 to 1966 produced a shipment of about 2 154 565 t of siliceous gold ore to the Noranda smelter; gold recovery amounted to 10 834 356 g. In 1989, Aunore Resources Inc. produced a small amount of gold. The workings consisted of two shafts, 381 m and 762 m deep; the shafts are about 750 m apart.

The mine is about 8 km northwest of Rouyn-Noranda and 5 km north of Évain. *See* Map 9 on page 61.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading north.
	3.6	Junction; continue straight ahead (north).
	5.2	Elder (Peel-Elder) mine.

Refs.: 61 p. 2, 5; 152 p. 7–10; 275 p. 14; 427 p. 69; 438 p. 263; 457 p. 61.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

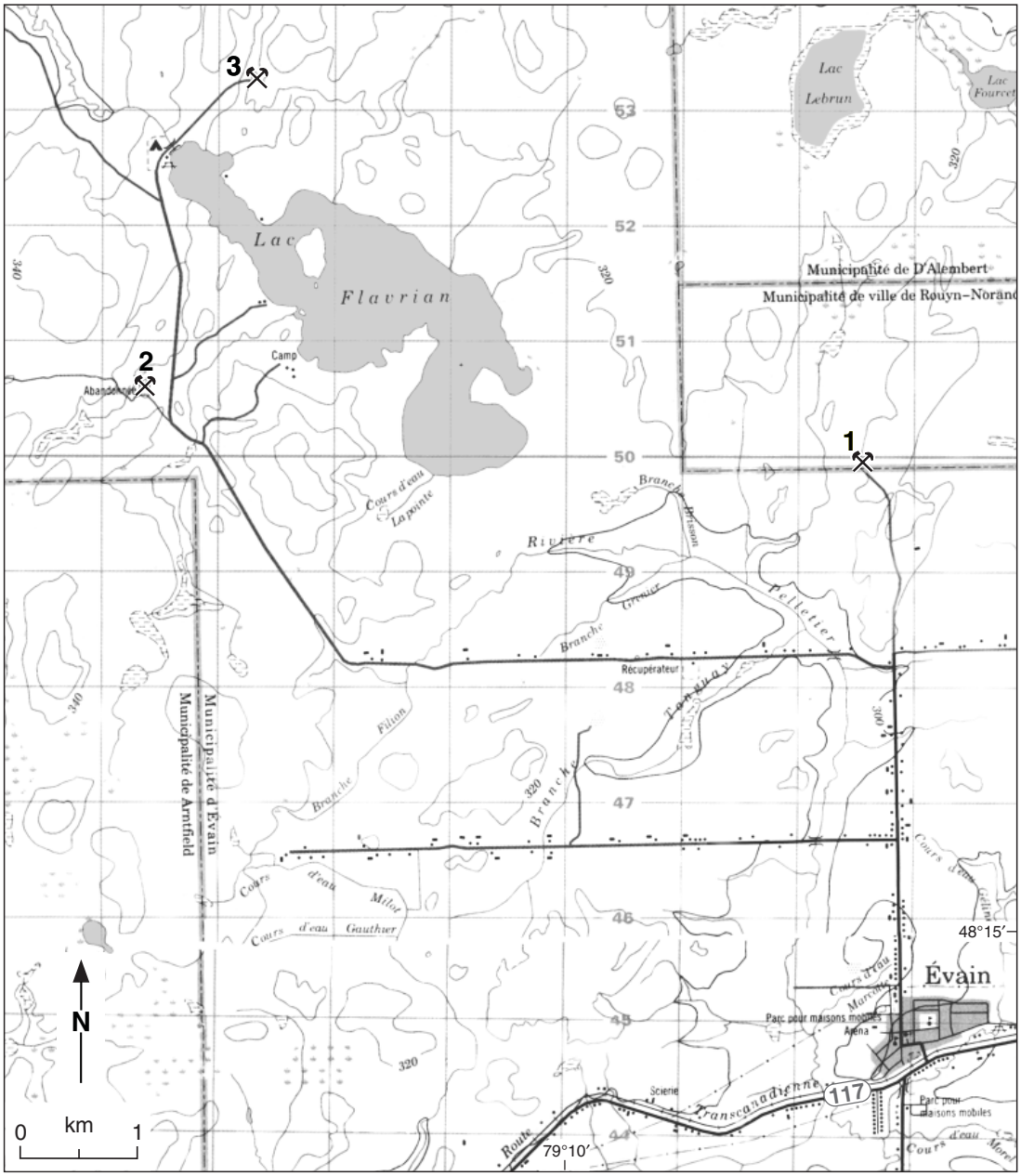
Quesabe mine

NATIVE GOLD, PYRITE, CALCITE, CHLORITE, EPIDOTE

In volcanic rocks

Native gold was associated with pyrite in quartz lenses and in the host rock; visible gold was rare. The dumps furnish specimens of coarsely cleavable white calcite (fluoresces bright pink when exposed to long ultraviolet rays), pink massive calcite, chlorite, epidote, and pyrite.

Part of 32 D/3, 6



1. Elder (Peel-Elder) mine 2. Quesabe mine 3. Eldrich (Pierre Beauchemin) mine

Map 9. Évain north

Birrell Gold Mines Limited did the original surface exploration in 1934. Other operators, including Flavrian Gold Mines Limited and Payco Gold Mines Limited, were involved in intermittent exploration and development until 1946 when Quesabe Mines Limited undertook mining operations. From 1950 to 1952, the mine produced about 885 000 g of gold from 103 000 t of ore. Development consisted of two shafts, 194 m and 320 m deep. A mill operated at the mine site.

The mine is about 16 km northwest of Rouyn-Noranda and 9 km northwest of Évain. It is just west of Flavrian Lake. *See* Map 9 on page 61.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading north.
	3.6	Junction; turn left (west).
	11.0	Junction, at a bend in the road. Follow the mine road on left leading northwest. (The main road bends northward.)
	11.6	Quesabe mine.

Refs.: 61 p. 33–34; 69; 83 p. 115; 130 p. 413–415; 291 p. 13–14; 332 p. 86–87.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
510 Flavrian Lake area, Abitibi and Témiscamingue counties (MRNQ, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Eldrich (Pierre Beauchemin) mine

NATIVE GOLD, PYRITE, CALCITE, CHLORITE, EPIDOTE, STILPNOMELANE, AMPHIBOLE

In granitic and dioritic rocks

Native gold was associated with pyrite in quartz veins. The rock dumps provide specimens of pyrite, chlorite, white calcite (fluoresces pink under long ultraviolet rays), and epidote. Stilpnomelane occurs with chlorite and radiating aggregates of amphibole. An ornamental rock consisting of epidote in pink to red granite is common in the dumps; the rock takes a good polish.

Capital Rouyn Gold Mines Limited did the original exploration in 1927–1929. The work consisted of trenches and a 15 m shaft sunk on chalcopyrite-gold-quartz veins. In 1938, A. Mondoux discovered pyrite-gold-quartz veins. Boulder Hill Mines Limited explored these veins in 1945–1947. Eldrich Mines Limited undertook development of the deposit in 1951. Production from 1955 to 1962 amounted to 3 112 663 g of gold from 650 912 t of ore. The mine was serviced by a 324 m shaft and the ore was processed at the Noranda smelter. Cambior Inc. acquired the property in 1987, deepened the shaft to 580 m, and began production in 1988. Operations ended in 1993. During this period, the mine produced about 4 794 000 g of gold and 639 000 g of silver.

The mine is about 17 km northwest of Rouyn-Noranda and 10 km northwest of Évain. It is just north of Flavrian Lake. *See* Map 9 on page 61.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading north.

	3.6	Junction; turn left (west).
	11.0	Junction, road to Quesabe mine; continue north along the main road.
	12.8	Junction; follow the road on right.
	14.3	Eldrich (Pierre Beauchemin) mine.

Refs.: 17 p. 7–8; 83 p. 116; 257 p. 92; 266 p. 211–219; 276 p. 10–11; 278 p. 13; 376 p. 13–14; 427 p. 70; 435 p. 58–59.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
510 Flavrian Lake area, Abitibi and Témiscamingue counties (MRNQ, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-08 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Durbar (Huronian Belt) mine

PYRITE, ARSENOPYRITE, NATIVE GOLD, CHROME MUSCOVITE, TOURMALINE, CHLORITE

In rhyolite

Pyrite occurs as grains and small cubes in quartz-calcite-feldspar veins. Arsenopyrite is associated with pyrite. Native gold occurs in the veins and in a chrome muscovite (fuschite)-quartz-carbonate zone in talc schist exposed in the open pit. Black tourmaline and chlorite occur in quartz.

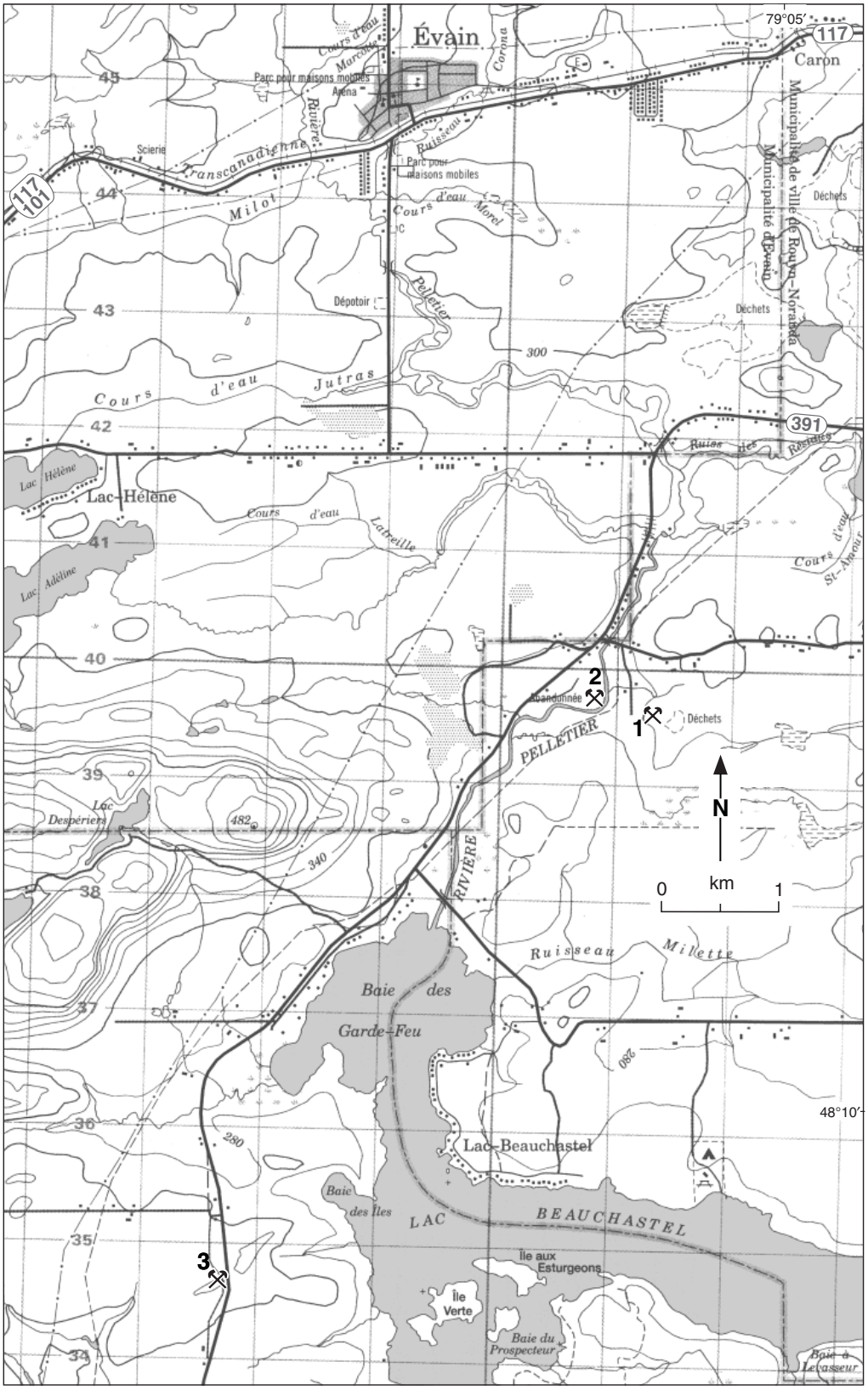
Huronian Belt Mining Company Limited staked the deposit in 1922. The company explored the property between 1923 and 1925 by several pits and trenches and a 14 m shaft. Normont Gold Mines Limited sank a shaft to 30 m in 1933–1934. Durbar Gold Mines Limited did some surface exploration in 1936. Between 1979 and 1991, Augmitto Explorations Limited deepened the shaft to 270 m, drove a ramp 1676 m to the 182 m level, and mined some ore from an open pit, 250 m long and 94 m wide. The company brought the mill from the Langmuir mine in Timmins to the site.

The mine is about 7 km southwest of Rouyn-Noranda and 5 km southeast of Évain. *See* Map 10 on page 64.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading south.
	2.8	T-junction; turn left (east).
	5.1	Junction, Highway 391; turn right (south).
	6.7	Junction; turn left onto a road leading east.
	6.95	Junction; turn right (south) onto the mine road.
	7.6	Durbar (Huronian Belt) mine. The original shaft is about 800 m to the northeast.

Refs.: 65 p. 275–276; 83 p. 146; 137 p. 52–55; 151 p. 68; 270 p. 14–15; 276 p. 15; 399 p. 56–59; 453 p. 50; 456 p. 53.



1. Durbar (Huronian Belt) mine 2. Riverside (Bazooka) mine
3. Canada Black Granite quarry

Map 10. Évain south

Maps (T): 32 D/3 Rouyn
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
1106A Southeast Beauchastel Township, Témiscamingue County, Quebec (GSC, 1:18 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Riverside (Bazooka) mine

PYRITE, TOURMALINE, NATIVE GOLD, CHLORITE

In sheared andesite

Some visible gold occurs in quartz. Pyrite, tourmaline, and chlorite occur in quartz-carbonate veins.

The property was originally known as the 'McDonough claim'. Riverside Gold Mines Limited explored the vein in 1935. In 1951, D'Eldona Gold Mines Limited sank a shaft to 125 m.

The mine is about 8 km southwest of Rouyn-Noranda and 5 km south of Évain. *See* Map 10 on page 64.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading south.
	2.8	T-junction; turn left (east).
	5.1	Junction, Highway 391; turn right (south).
	6.7	Junction, road on left leading east; continue along Highway 391.
	7.5	Junction; turn left (east) onto the mine road.
	7.9	Riverside (Bazooka) mine.

Refs.: 137 p. 55; 151 p. 4–8; 399 p. 54–56.

Maps (T): 32 D/3 Rouyn
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
1106A Southeast Beauchastel Township, Témiscamingue County, Quebec (GSC, 1:18 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Canada Black Granite quarry

GABBRO

In dyke cutting Precambrian sedimentary rocks

The gabbro is fine to medium grained and composed of labradorite, augite, and magnetite with some olivine. It takes a high polish exhibiting a uniform distribution of black, bluish-grey, and light grey tones. It was known commercially as 'black granite' and was used as a monument stone. The gabbro occurs in a dyke, about 150 m wide, extending southwesterly from Beauchastel (KeKeKo) Lake almost to Baie à l'Orignal on the east side of Opasatica Lake.

Canada Black Granite Company Limited opened the quarry in 1950 and worked it for a few years.

The quarry is about 13 km southwest of Rouyn-Noranda and 10 km south of Évain. *See* Map 10 on page 64.

Road log from Highway 117 at **km 91.1** (*see* p. 8):

km		
	0	Junction, in Évain; proceed along the road leading south.
	2.8	T-junction; turn left (east).
	5.1	Junction; turn right (south) onto Highway 391.
	12.6	Junction; follow the road on right.
	13.8	Junction, quarry road; turn right (west).
	13.95	Canada Black Granite quarry.

Ref.: 52 p. 73–75.

Maps (T): 32 D/3 Rouyn
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
1106A Southeast Beauchastel Township, Témiscamingue County, Quebec (GSC, 1:18 000)

Horne mine

PYRITE, CHALCOPYRITE, PYRRHOTITE, SPHALERITE, MAGNETITE, ALTAITE, NATIVE GOLD, ELECTRUM, HESSITE, PETZITE, SYLVANITE, KRENNERITE, CALAVERITE, TELLUROBISMUTHITE, RICKARDITE, KLOCKMANNITE, UMANGITE, GALENA, TETRAHEDRITE, EPIDOTE, CLINOZOISITE, CHLORITE, OTTRELITE

In siliceous, chloritized, and sericitized rhyolite

The massive-sulphide ore consisted of pyrite, chalcopyrite, pyrrhotite, sphalerite, and magnetite. Also present were native gold and electrum, the tellurides hessite, petzite, sylvanite, krennerite, calaverite, altaite, tellurobismuthite, and rickardite, and the selenides klockmannite and umangite. Galena and tetrahedrite have been reported. Epidote, clinozoisite, chlorite, and ottrelite occur in the host rocks.

Edmund Henry Horne discovered the deposit as an outcrop of rusty weathered sulphide-bearing rock in 1917 after prospecting the area in 1911 and 1914. On September 11, 1920, he and his partner, Ed Miller, staked the claims that became the Noranda mine; the claims were staked on behalf of the Tremoy Lake Prospecting Syndicate that was formed in New Liskeard to finance prospecting in adjacent parts of Quebec. In 1922, Noranda (Northern Canada) Mines Limited was incorporated to develop the property. The mine produced continuously from 1927 to 1976. The workings consisted of five surface shafts and two internal shafts to 1836 m and 2440 m. A

Plate 8

Horne mine, 1924. National Archives Canada PA 13660

concentrator, smelter, and cyanide mill operated at the mine site. The mine produced 1 179 100 t of copper, 311 030 kg of gold, 693 597 kg of silver, 4 535 000 t of pyrite, and some selenium and tellurium, from 5 378 807 t of ore. Mining operations in 1985–1989 from an open pit and from underground produced auriferous flux from mineralized rhyolite for use in the Noranda (Horne) smelter.

The Horne mine site is in Parc Industriel (Secteur Noranda) in Rouyn-Noranda. *See* Map 11 on page 68.

Refs.: 13 p. 30–35; 115 p. 29–30; 141 p. 41–44; 165 p. 153–161; 245 p. 13–14; 287 p. 25; 337 p. 349, 352, 354, 356, 359, 362, 369, 380; 361 p. 35–38; 398 p. 82–98; 444 p. 244, 246; 445 p. 251–252; 448 p. 231.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)

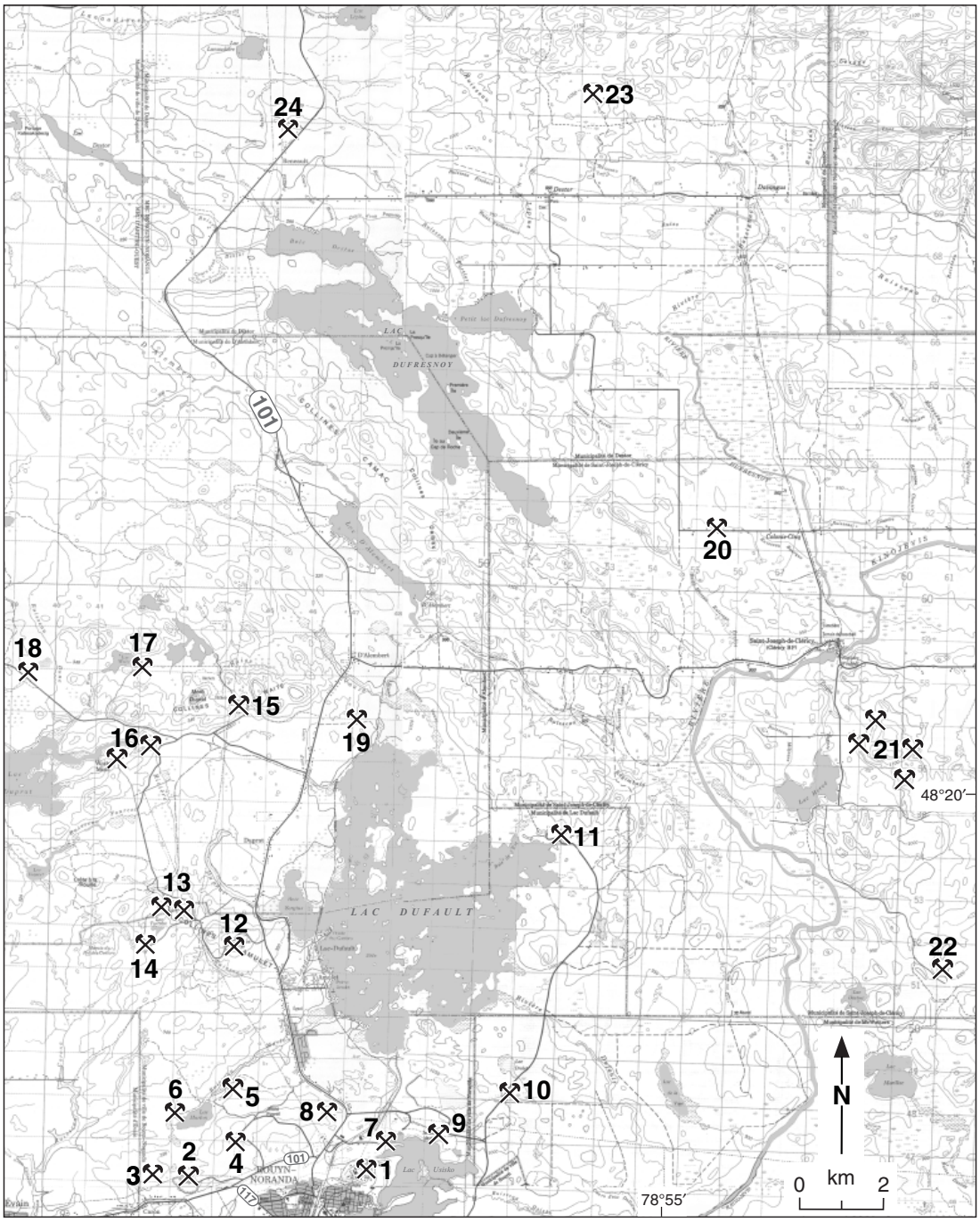
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)

2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)

M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Mines along highways 101 north and 111

Collecting localities along Highway 101 to Macamic and Highway 111 from Macamic to Normétal are described in the follows pages. The starting point is the junction of highways 117 and 111 at **km 96.9** (*see* p. 8) at the west end of Rouyn-Noranda.



1. Horne mine 2. Don Rouyn mine 3. Silidor mine 4. Powell Rouyn mine 5. Pontiac Rouyn (Anglo Rouyn) mine 6. Marlon Rouyn (New Marlon) mine 7. Quemont mine 8. Joliet mine 9. Donalda (Kerralda) mine 10. D'Eldona (Delbridge) mine 11. MacDonald (Gallen) mine 12. Millenbach mine 13. Amulet mine 14. Corbet mine 15. Norbec (Lake Dufault) mine 16. Waite-Ackerman-Montgomery (Old Waite) mine 17. Vauze mine 18. Ansil mine 19. Newbec mine 20. Mobrun (Bouchard-Hébert) mine 21. Harvie (Archean) mine 22. LeRoy (Roybell, Claremont) mine 23. Vezina (Thurbois) mine 24. Duquesne mine

Map 11. Rouyn-Noranda north.

Don Rouyn mine

NATIVE GOLD, CHALCOPYRITE, PYRITE, MOLYBDENITE, BORNITE

In granitic rocks

Native gold was associated with chalcopyrite, bornite, pyrite, molybdenite, and hematite in quartz-ankerite veins. Granite containing epidote and chlorite is found in the mine dumps.

Don Rouyn Mines Limited explored the deposit between 1925 and 1929 by several surface openings and a 30 m shaft. The exploration failed to reveal economic ore. From 1958 to 1980, Noranda Mines Limited mined silica from an open pit near the old shaft. The silica was used as flux in the Noranda smelter.

The mine is about 2 km west of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	0.3	Junction; turn left (west) onto Don Rouyn Road.
	1.5	Don Rouyn mine.

Refs.: 65 p. 228–229; 83 p. 155–156; 160 p. 72–75; 239 p. 178; 398 p. 144–145.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Silidor mine

NATIVE GOLD, PYRITE, CHROME MUSCOVITE, CHALCOPYRITE, GALENA, SPHALERITE, PYRRHOTITE, MOLYBDENITE, HESSITE, GOETHITE, HEMATITE, COVELLITE, CHALCOCITE, MALACHITE

In altered tonalite

Native gold occurred as fine grains in quartz, pyrite, and in carbonates associated with carbonate-chrome muscovite (fuchsite) breccia and hematized tonalite. Chalcopyrite, galena, sphalerite, pyrrhotite, molybdenite, and hessite occurred as traces in quartz. Hematite (specularite) occurred as fine veinlets in the host rock. Oxidized zones contained goethite, hematite, covellite, chalcocite, and malachite.

The deposit was discovered in 1985 as a result of drilling. Cogesco Mining Resources Inc. outlined the orebody in 1986–1987. Mines Silidor Inc. undertook development in 1988. Production began in 1989–1990 from a 560 m shaft. The mine produced about 12 313 kg of gold and 2194 kg of silver from 1989 to 1995.

The mine is about 2 km west of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	0.3	Junction; turn left (west) onto Don Rouyn Road continung past the Don Rouyn mine.
	2.4	Silidor mine.

Refs.: 108 p. 12, 13; 239 p. 175–183; 277 p. 13, 14; 375 p. 12, 13; 458 p. 82, 272; 462 p. 77, 190; 463 p. 85, 210.

Maps (T): 32 D/6 Rivière Kanasuta

(G) 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Powell Rouyn mine

PYRITE, NATIVE GOLD, TETRADYMITE, CHALCOPYRITE, HEMATITE, MARCASITE, CHROME MUSCOVITE, SPHALERITE, GUNNINGITE, EPIDOTE, CHLORITE, CALCITE, SIDERITE, JAROSITE

In granite and diabase

Mineralization consisted mainly of gold-bearing pyrite in quartz veins. Free gold in the native state was rare. Tetradymite occurred as stringers associated with chlorite, pink calcite crystals, pyrite, and native gold. Chalcopyrite, specular hematite, and marcasite were associated with pyrite. Green chrome muscovite (fuchsite) has been reported from this deposit. Specimens available from the dumps include brown sphalerite coated with white gunningite, epidote as microcrystals in cavities in massive quartz-epidote rock, chlorite associated with epidote, white massive calcite that fluoresces deep pink under long ultraviolet rays, dark brown siderite, platy specular hematite, pyrite as cubes in quartz and in siderite, and yellow powdery jarosite on ore specimens.

Tom W. Powell discovered the gold mineralization in 1922. The discovery of gold-bearing quartz veins on this property and on the nearby Horne claim sparked the prospecting rush in the Rouyn district in the following year. Early exploration of the Powell deposit was conducted by the Chadbourne-Thompson Syndicate (1923), Nipissing Mining Company (1923–1924), and Powell Mining Properties Limited (1927–1931), who shipped some gold-bearing ore from a weathered outcrop to the Noranda smelter. In 1933, Powell Rouyn Gold Mines Limited undertook underground development and produced siliceous gold ore from 1937 to 1955. The ore was used as a direct-fluxing ore for the Noranda Mines Limited copper smelter. Production amounted to 11 841 814 g of gold and 544 956 g of silver from 2 797 775 t of ore. The workings consisted of a production shaft to 979 m and two other shafts to 170 m and 110 m.

The mine is about 2 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	2.1	Junction; turn left (north) onto Powell Road.
	3.9	Junction, at a bend in the road; follow the road on left leading southwest.
	4.3	Powell Rouyn mine.

Refs.: 65 p. 236–240; 209 p. 739–747; 337 p. 372, 380; 398 p. 125–132; 427 p. 158–159.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Pontiac Rouyn (Anglo Rouyn) mine

NATIVE GOLD, CHALCOPYRITE, PYRITE, SPHALERITE, TOURMALINE

In sheared andesite

Native gold occurred with chalcopyrite and pyrite in quartz veins. Some sphalerite and tourmaline were also present.

The property consisted of claims originally staked by Hilda Cockeram, R. Cockeram, W. Crawford, M.G. Grover, G.F. Summers, and D. Willans. Pontiac Rouyn Mines Limited did some development work between 1928 and 1938, and shipped 901 t of ore to the Noranda smelter. Anglo-Rouyn Mines Limited resumed mining in 1943. Underground development via a shaft and winze extended to the 296 m level. Total production from 1948 to 1951 amounted to 1 033 335 g of gold and 626 725 g of silver, from 132 157 t of ore.

The mine is about 3 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	2.1	Junction; turn left (north) onto Powell Road.
	3.9	Junction, at a bend in the road; follow the road on right leading northwest to Marlon Lake.
	5.1	Junction, at Marlon Lake; turn right onto the road leading northeast.
	5.7	Pontiac Rouyn (Anglo Rouyn) mine.

Refs.: 83 p. 154–155; 398 p. 132–135.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Marlon Rouyn (New Marlon) mine

NATIVE GOLD, PYRITE, CHALCOPYRITE

In chloritized rhyolite

Native gold occurred in quartz veins and in quartz-carbonate stringers. Pyrite and minor chalcopyrite were also present.

Marlon Rouyn Gold Mines Limited (renamed 'New Marlon Gold Mines Limited' in 1946) discovered gold mineralization on the property by drilling in 1944–1946. The company mined the deposit via a 252 m shaft in 1947–1949, producing 79 737 t of ore valued at $673 994.

The mine is about 4 km northwest of Rouyn-Noranda, near the southwestern end of Marlon Lake. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	2.1	Junction; turn left (north) onto Powell Road to Marlon Lake.
	5.5	Junction; continue straight ahead (southwest).
	6.1	Marlon Rouyn (New Marlon) mine.

Refs.: 155 p. 126–127; 423 p. 139.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Quemont mine

PYRITE, PYRRHOTITE, SPHALERITE, CHALCOPYRITE, MAGNETITE

In rhyolite breccia

Pyrite was the most common mineral in the ore; it occurred as disseminated grains, and in massive form with pyrrhotite, sphalerite, chalcopyrite, and magnetite.

The property, staked as the Murray claims in 1922, adjoins the Horne mine to the northeast. United Verde Extension Mining Corporation sank a shaft to 72 m in 1927 and located a small body of siliceous gold ore. In the following year, Quemont Mining Corporation deepened the shaft to 281 m, but failed to locate an economic orebody. A subsequent drilling program conducted in 1944–1945 disclosed a large tonnage of gold-silver-copper-zinc ore beneath Osisko (Tremoy) Lake. Mining via a new 1266 m shaft began in 1949 and ended in 1971. Production amounted to 167 613 t of copper, 59 664 884 g of gold, 247 010 695 g of silver, 254 232 t of zinc, and 3 348 644 t of pyrite concentrates, from 13 921 543 t of ore milled.

The mine is about 1.5 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	2.8	Junction; turn right (east).
	4.0	Centre Quémont, Parc industriel (Secteur Noranda). The Quemont mine shafts are near the north shore of Osisko Lake, just southeast of Centre Quémont.

Refs.: 334 p. 405–413; 398 p. 145; 444 p. 177–178.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Joliet mine

NATIVE GOLD, PYRITE, CHALCOPYRITE

In rhyolite breccia

Native gold and pyrite occurred in quartz stringers. Pyrite and chalcopyrite occurred in the host rock.

J.A. Brownlee, C.J. Brett, J.J. Richardson, A.C. Richardson, and Mrs. A.D. Richardson staked the original claims in 1922 during the Rouyn prospecting rush. Joliet-Quebec Mines Limited sank a shaft to 305 m in 1945 and discovered a copper orebody. Ore was mined via an underground connection to the Horne mine. The mine produced siliceous ore for use as flux for the Noranda smelter from 1954 to 1974. Production amounted to 1 465 403 t of ore averaging 0.905% copper.

The Joliet mine is about 2 km north of Rouyn-Noranda, on the west side of Highway 101 at a point 3.4 km from the junction of highways 117 and 101 in Rouyn-Noranda. *See* Map 11 on page 68.

Refs.: 83 p. 155; 154 p. 26–27; 239 p. 225; 398 p. 144; 428 p. 105.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
453A Rouyn area, Rouyn Township, Témiscamingue County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Donalda (Kerralda) mine

PYRITE, NATIVE GOLD, CHALCOPYRITE, SPHALERITE, GALENA, EPIDOTE, ACTINOLITE, HEMATITE, CHLORITE, CALCITE

In porphyritic rhyolite

The ore consisted of pyrite and native gold, with minor amounts of chalcopyrite, sphalerite, and galena in quartz veins. The dumps furnish specimens of pyrite (as tiny cubes), epidote containing microprisms of actinolite and specular hematite, and specimens of coarse cleavable masses of pink and white calcite. The white calcite fluoresces bright orange-pink when exposed to ultraviolet rays.

John A. Brownlee staked the original claims in the 1920s. A 1943 drilling program conducted by Donalda Mines Limited revealed a gold orebody on the property. The company sank a shaft to 219 m and began production in 1948. The ore was shipped to the mill at the Powell Rouyn mine. A new mill at the mine site began treating the ore in 1951. Mining ended in 1956. Production amounted to 3 548 075 g of gold and 3 160 687 g of silver, from 630 557 t of ore. Kerralda Mines Limited produced a small amount of gold and silver in 1970–1971. Ressources Minorca Inc. resumed operations in 1994–1995 and produced about 340 kg of gold.

The mine is about 3 km northeast of Rouyn-Noranda, at the northeastern end of Osisko Lake. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	3.4	Junction; turn right (east) onto Chemin de la Mine McDonald.
	6.4	Donalda (Kerralda) mine, on the right (west) side of the road.

Refs.: 2 p. 59–60; 61 p. 55–56; 107 p. 13; 108 p. 14, 15; 239 p. 226–227; 279 p. 199–209; 382 p. 295; 430 p. 85; 463 p. 282.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

D'Eldona (Delbridge) mine

PYRITE, SPHALERITE, CHALCOPYRITE, GALENA, TETRAHEDRITE, NATIVE GOLD, ELECTRUM, ARSENOPYRITE, NATIVE SILVER, TOURMALINE

In rhyolite breccia and tuff

The ore consisted of massive and disseminated pyrite and silver-bearing sphalerite, with minor amounts of chalcopyrite, galena, and tetrahedrite, and some native gold, electrum, and arsenopyrite. Native silver occurred in quartz-carbonate veinlets in the massive-sulphide ore. Tourmaline (schorl-dravite) crystals occur in a rhyolite alteration zone associatd with the orebody.

D'Eldona Gold Mines Limited discovered a small orebody on the property in 1947 and mined it via a 457 m shaft from 1950 to 1952. The operation yielded 81 630 t of ore containing 7.7% zinc, 68.57 g/t gold, and 5.828 g/t silver. From October 1969 to September 1971, Delbridge Mines Limited mined a new deposit (400 m south of the D'Eldona deposit) and produced over 1 966 473 kg of copper, 30 894 147 kg of zinc, 808 678 g of gold, and 24 260 340 g of silver, from 360 079 t of ore.

The mine is about 4 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	3.4	Junction; turn right (east) onto Chemin de la Mine McDonald.
	6.4	Donalda mine, on the right (west) side of the road; continue along Chemin de la Mine McDonald.
	7.3	Junction; the mine road leads straight ahead (northeast).
	8.1	D'Eldona (Delbridge) mine.

Refs: 13 p. 35–36; 35 p. 59: 55 p. 11, 15; 115 p. 30–33; 239 p. 228; 382 p. 295; 425 p. 66; 444 p. 106; 445 p. 106.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

MacDonald (Gallen) mine

PYRITE, SPHALERITE, CHALCOPYRITE, GALENA

In volcanic rocks

The ore consisted of pyrite and sphalerite with minor chalcopyrite and galena.

MacDonald Mines Limited discovered copper-gold mineralization on the property in 1937–1938. Further exploration in 1946–1947 resulted in the discovery of an ore zone containing zinc mineralization. West MacDonald Mines Limited mined this deposit from 1955 to 1959

via a 290 m shaft. MacDonald Mines Limited operated the mine from an open pit between 1981 and 1985. Total production amounted to 1 683 374 t of ore containing 34 000 t of zinc, 3184 kg of silver, and 810 kg of gold.

The mine is about 10 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	3.4	Junction; turn right (east) onto Chemin de la Mine McDonald.
	7.3	Junction; turn left (northeast).
	15.6	MacDonald (Gallen) mine.

Refs.: 4 p. 49–50; 69; 83 p. 119–120; 133 p. 150; 374 p. 33–36; 388 p. 29–33; 389 p. 167–174; 433 p. 257–258; 451 p. 254; 453 p. 250, 280–282.

Maps (T): 32 D/7 Cléricy

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Millenbach mine

PYRITE, PYRRHOTITE, CHALCOPYRITE, SPHALERITE, MAGNETITE, GALENA, ARSENOPYRITE, MACKINAWITE, NATIVE SILVER

In andesite and rhyolite

The ore consisted of massive-sulphide lenses containing pyrite, pyrrhotite, chalcopyrite, and sphalerite. Minor amounts of magnetite and traces of galena, arsenopyrite, mackinawite, and native silver were also present.

Lake Dufault Mines Limited discovered the deposit in 1966 by drilling. Falconbridge Copper Limited (Lake Dufault Division) operated the mine from 1971 to 1981 from a 1215 m shaft. The ore was trucked to the Norbec mill for treatment. Production amounted to 3 423 000 t of ore containing 112 000 t of copper, 113 000 t of zinc, 122 000 kg of silver, and 2597 kg of gold.

The mine is about 6 km north of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	8.4	Junction; turn left (west).
	9.4	Millenbach mine.

Refs.: 69; 170 p. 255–295; 316 p. 67–78; 444 p. 125.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
454A Amulet area, Duprat, Dufresnoy, Rouyn, and Beauchastel townships, Abitibi and Témiscamingue counties, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Amulet mine

CHALCOPYRITE, SPHALERITE, PYRRHOTITE, PYRITE, GALENA, NATIVE GOLD, DALMATIANITE

In andesite and rhyolite

The ore consisted of chalcopyrite, sphalerite, pyrrhotite, pyrite, and some galena. Native gold occurred as veinlets in pyrite. Dalmatianite, a dark brownish-black volcanic rock containing white spots or blotches up to 2 cm across, was associated with the orebody. The striking rock was referred to as 'dalmatianite' by the miners because of its resemblance to a Dalmatian dog. It is believed to be an altered amygdaloidal rhyolite.

The McDonough brothers staked the deposit in the winter of 1922–1923. Amulet Gold Mines Limited explored the deposit in 1924–1929 and discovered three orebodies. The company mined 654 684 t of ore in 1930. Waite Amulet Mines Limited resumed production in 1937, continuing until 1962. Development consisted of three shafts, 78 m, 108 m, and 421 m deep. Aerial tramways connected the shafts to the mill. The mine produced copper, zinc, gold, and silver.

The Amulet mine is about 8 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	8.4	Junction; turn left (west).
	11.2	Amulet mine. Two shafts and the mill site are here; a third shaft is 1370 m to the northwest.

Refs.: 64 p. 39–43; 83 p. 361–383; 322 p. 757–762; 385 p. 9, 10; 398 p. 99–111.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
454A Amulet area, Duprat, Dufresnoy, Rouyn, and Beauchastel townships, Abitibi and Témiscamingue counties, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Corbet mine

PYRRHOTITE, PYRITE, CHALCOPYRITE, SPHALERITE, MAGNETITE, GALENA, NATIVE GOLD, MACKINAWITE, TETRADYMITE, KRENNERITE

In andesite

The orebody consisted predominantly of pyrrhotite, pyrite, chalcopyrite, and sphalerite, with minor magnetite and galena. Native gold was associated with pyrite. Mackinawite, tetradymite, and krennerite occurred in trace amounts. The gangue consisted of quartz, chlorite, and sericite.

Thayer Lindsay staked the deposit in 1926. McDougall Mines Limited explored it via a 366 m shaft in 1926–1927. Falconbridge Copper Limited sank a shaft to 1218 m in 1975 and mined the deposit from 1980 to 1986. Production amounted to about 2 753 000 t of ore containing 39 000 t of copper, 10 000 t of zinc, 17 000 kg of silver, and 2413 kg of gold.

The mine is about 8 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	8.4	Junction; turn left (west).
	11.2	Junction, at the Amulet mine; continue along the road leading west.
	11.6	Corbet mine.

Refs.: 13 p. 19–21; 14 p. 31–33; 69; 169 p. 297–317; 398 p. 141–142.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
454A Amulet area, Duprat, Dufresnoy, Rouyn, and Beauchastel townships, Abitibi and Témiscamingue counties, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Norbec (Lake Dufault) mine

PYRITE, SPHALERITE, CHALCOPYRITE, PYRRHOTITE, MAGNETITE, GALENA

In andesite and rhyolite

The massive-sulphide orebody consisted of pyrite, sphalerite, and chalcopyrite, with minor pyrrhotite, magnetite, and galena.

Norbec Copper Mines Limited did the original surface exploration in 1944. Lake Dufault Mines Limited discovered a massive-sulphide orebody in 1961 by drilling, and mined it from 1964 to 1974. Production was from a 609 m shaft. A mill operated at the mine site. The mine produced about 3 720 000 t of ore containing 98 000 t of copper, 144 000 t of zinc, 141 000 kg of silver, 2311 kg of gold, and some lead and cadmium.

The Norbec (Lake Dufault) mine is about 12 km northwest of Rouyn-Noranda. Access is by a 1 km road leading northeast from km 15.1 on the road to the Waite-Ackerman-Montgomery mine (this page). *See* Map 11 on page 68.

Refs.: 13 p. 28–30; 69; 248 p. 53–54; 253 p. 39–40; 257 p. 85; 382 p. 123; 444 p. 125.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
455A Waite area, Duprat and Dufresnoy townships, Abitibi County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Waite-Ackerman-Montgomery (Old Waite) mine

PYRITE, SPHALERITE, PYRRHOTITE, CHALCOPYRITE, MAGNETITE, GALENA, NATIVE SILVER, NATIVE GOLD, COSALITE, ELECTRUM, CALAVERITE, DALMATIANITE

In andesite and rhyolite

The massive-sulphide ore consisted of pyrite, sphalerite, pyrrhotite, and chalcopyrite, with minor magnetite, galena, native silver, native gold, and cosalite. Traces of electrum and calaverite were reported. The striking rock referred to as 'dalmatianite' occurred here as at the Amulet mine.

Thomas Montgomery discovered the deposit in 1925, when he observed a patch of ore in the root of a tree uprooted from muskeg by the wind. He staked it on behalf of himself, J.H.C. Waite, and C.H. Ackerman. Waite-Ackerman-Montgomery Mines Limited mined the deposit from 1928 to 1932 from an open cut and from a 311 m shaft. Waite Amulet Mines Limited resumed operations in 1937, sank No. 2 shaft to 436 m, and built an aerial tramway connection to the mill at the Amulet mine. In 1949, the company discovered a new copper-zinc orebody (East Waite) 457 m farther east, and mined it from 1952 to 1961 from a 634 m shaft. The mine produced about 109 000 t of copper, 78 000 t of zinc, 4091 kg of gold, and 73 790 kg of silver from 2 490 000 t of ore.

The mine is about 12 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	12.7	Junction; turn left (west).
	15.1	Junction, road on right leading northeast to the Norbec mine; proceed along the road on left leading west.
	16.0	Junction; proceed onto the road on left leading southwest.
	16.35	East Waite shaft. Proceed along the road leading west.
	17.2	Waite-Ackerman-Montgomery (Old Waite) mine. (A 3.5 km road leads south to the Amulet mine.)

Refs.: 63 p. 44; 69; 83 p. 361–383; 246 p. 748–752; 398 p. 111–123.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
455A Waite area, Duprat and Dufresnoy townships, Abitibi County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Vauze mine

CHALCOPYRITE, PYRRHOTITE, SPHALERITE, PYRITE, MAGNETITE

In rhyolite and andesite

The orebody consisted of chalcopyrite, pyrrhotite, sphalerite, pyrite, and magnetite. The gangue minerals included quartz, chlorite, and carbonates.

J.H.C. Waite staked the original claims around Waite Lake in 1923. Several companies did surface exploration between 1928 and 1945. Consolidated Vauze Mines Limited located an orebody in 1957–1958, and began mining operations from a 236 m shaft in 1960. Production from 1961 to 1965 amounted to 348 975 t of ore yielding 10 127 t of copper, 3329 t of zinc, 228 140 g of gold, and 9 237 746 g of silver.

The mine is about 13 km northwest of Rouyn-Noranda, at the southeastern end of Waite Lake. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	12.7	Junction; turn left (west).
	15.1	Junction, road on right leading northeast to the Norbec mine; continue along the road leading west.
	16.0	Y-junction; follow the road on right leading west. (The road on left leads to the East Waite shaft.)
	17.7	Junction; turn right (north) onto the mine road.
	19.3	Vauze mine.

Refs.: 318 p. 102–110; 398 p. 135.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
455A Waite area, Duprat and Dufresnoy townships, Abitibi County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Ansil mine

CHALCOPYRITE, PYRRHOTITE, SPHALERITE, MAGNETITE, NATIVE GOLD, ELECTRUM, NATIVE BISMUTH, COBALTITE, TELLUROBISMUTHITE, EPIDOTE

In rhyolite and andesite

The massive-sulphide orebody consisted mainly of chalcopyrite and pyrrhotite, with lesser amounts of sphalerite, and minor pyrite. Magnetite was associated with the sulphides. Native gold, electrum, native bismuth, cobaltite, and tellurobismuthite occurred in trace amounts. Epidote occurred with chlorite and sericite in altered rhyolite.

Ansil Mines Limited investigated the deposit between 1957 and 1959. Minnova Inc. discovered a massive-sulphide deposit in 1981 and mined it via a 1500 m shaft from 1989 to 1993. The mine produced 938 745 t of ore recovering 100 149 693 kg of copper, 235 560 kg of zinc, 28 840 443 g of silver, and 5 877 534 g of gold.

The mine is about 14 km northwest of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed north-east along Highway 101.
	12.7	Junction; turn left (west)
	15.1	Junction, road on right leading northeast to the Norbec mine; continue along the road leading west.
	16.0	Y-junction; follow the road on right leading west. (The road on left leads to the East Waite shaft.)
	17.7	Junction; continue straight ahead (west).
	19.7	Ansil mine, on the north side of the road.

Refs.: 13 p. 21–28; 54 p. 30, 41–42; 280 p. 143–150; 388 p. 24–26; 459 p. 239; 460 p. 229–230.

Maps (T): 32 D/6 Rivière Kanasuta

(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
833 Duprat Township, north-east part, Rouyn-Noranda (MRNQ, 1:24 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Fabie Bay (New Insco) mine

CHALCOPYRITE, PYRRHOTITE, PYRITE

In rhyolite and dacite

Chalcopyrite, pyrrhotite, and pyrite occurred in massive form in the host rocks.

New Insco Mines Limited located a copper orebody near the shore of Fabie Bay, Duparquet Lake, during a drilling program in 1972–1973. In 1975, Noranda Mines Limited undertook development consisting of a decline and an open pit. In 1976–1977, the company shipped 93 421 t of ore to its mill at the Horne mine in Noranda for testing.

The mine is about 35 km northwest of Rouyn-Noranda.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	12.7	Junction; turn left (west) and proceed toward the Ansil mine.
	19.7	Ansil mine. Continue northwest along this road.
	42.4	Junction; turn right (east).
	44.3	Fabie Bay (New Insco) mine.

Refs.: 221 p. 36; 448 p. 209.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
281A Duparquet sheet, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Newbec mine

CHALCOPYRITE, PYRITE, PYRRHOTITE

In andesite

Chalcopyrite, pyrite, and pyrrhotite occurred with quartz and calcite in chloritized andesite.

Norbec Mines Limited did the original exploration on this deposit in 1925. Newbec Mines Limited explored the deposit from 1927 to 1930 and sank a shaft to 76 m. About 252 t of ore containing 6.74% copper were shipped to the smelter at Noranda.

The Newbec mine is about 11 km north of Rouyn-Noranda. Access is by a 0.5 km road leading east from Highway 101 at a point 13.9 km from its junction with Highway 117 at **km 96.9** (*see* p. 8). *See* Map 11 on page 68.

Refs.: 65 p. 231–233; 83 p. 118; 257 p. 86; 398 p. 123–125.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
456A Newbec area, Dufresnoy Township, Abitibi County, Quebec (GSC, 1:9600)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)

M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Mobrun (Bouchard-Hébert) mine

PYRITE, CHALCOPYRITE, SPHALERITE, GALENA, PYRRHOTITE, NATIVE GOLD, DIGENITE, MAGNETITE

In rhyolite breccia and sericite schist

The ore consists mainly of pyrite, chalcopyrite, and sphalerite, with lesser amounts of galena, pyrrhotite, native gold, digenite, and magnetite. The gangue consists of quartz, carbonate, sericite, and chlorite.

Rio Canadian Exploration Limited discovered the deposit in 1956 following a survey along regional roads using a wheel-mounted electromagnetic unit. The name of the deposit is an acronym derived from 'mobile road unit'. Mobrun Copper Limited outlined a copper deposit in 1955–1956. Audrey Resources Inc. undertook development in 1986 and mined the deposit from an open pit and a 396 m shaft. Production from 1987 to 1992 amounted to 7 833 850 kg of copper, 22 765 383 kg of zinc, 7 845 390 g of silver, and 1 449 305 g of gold. Cambior Inc. resumed production in 1995. Production in 1995–1997 amounted to 79 700 t of zinc, 19 700 t of copper, 2643 kg of gold, and 13 769 kg of silver.

The mine is about 21 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	15.7	Junction; turn right (east) onto Chabot Road.
	27.7	Junction, in Saint-Joseph-de-Cléricy; turn left (north).
	30.5	Junction; turn left (west).
	32.6	Mobrun (Bouchard-Hébert) mine.

Refs.: 13 p. 37–44; 56 p. 133–142; 107 p. 6, 9, 10; 269 p. 73–83; 365 p. 99; 388 p. 26–29; 455 p. 54; 456 p. 52–53; 458 p. 53; 460 p. 47; 463 p. 85; 474 p. 91–92; 475 p. 94–95.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Harvie (Archean) mine

CHALCOPYRITE, PYRITE, PYRRHOTITE, SPHALERITE

In volcanic rocks

Chalcopyrite, pyrite, pyrrhotite, and sphalerite occur as disseminated grains in andesite and dacite, and in quartz veins cutting the volcanic rocks.

R. Harvie discovered the copper mineralization and formed Archean Mines Development Company Limited in 1924 to explore it. In 1926–1927, Harvie Mining Exploration Company Limited examined the property. Development consisted of three shafts sunk to 40 m, 32 m, and 33.5 m respectively, and an adit driven east about 244 m into a hill. United Obalski Mining Company Limited re-examined the property in 1961–1965 and shipped a 22 t test sample to the Noranda smelter.

The mine is about 17 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	15.7	Junction; turn right (east) onto Chabot Road.
	27.7	Junction, in Saint-Joseph-de-Cléricy; continue straight ahead (east).
	28.7	Junction; turn right (south).
	30.4	Junction; turn left (east).
	30.7	End of the road. The Harvie (Archean) mine adit is about 150 m south of this point. A trail continues 600 m northeast from the end of the road to No. 4 shaft. The other shafts are 1350 m east and 1700 m southeast of the end of the road.

Refs.: 4 p. 38; 65 p. 229–230; 144 p. 9–11; 365 p. 96–97.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
1463 South west quarter of Cléricy Township, County of Rouyn-Noranda (MRNQ, 1:12 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

LeRoy (Roybell, Claremont) mine

NATIVE GOLD, CHALCOPYRITE, PYRRHOTITE, PYRITE, TOURMALINE, EPIDOTE, TITANITE, ACTINOLITE

In diorite

Native gold occurs as free grains in quartz fractures and associated with chalcopyrite, pyrrhotite, and pyrite in quartz veins. The veins occur in shear zones and contain calcite, tourmaline, epidote, titanite, albite, and minor actinolite, chlorite, and sulphide minerals.

O'Brien Gold Mines Limited explored the gold-bearing quartz veins in 1935. LeRoy Mines Limited (renamed 'Roybell Mines Limited' in 1939) sank an 81 m shaft in 1937 and did some underground exploration. Claremont Mines Limited did some drilling in 1947. Les Mines

d'Étain du Québec Limitée undertook further exploration by an open pit in 1976–1977. Shipments included vein material to the Noranda smelter for siliceous flux testing in 1977 and small ore shipments to the Pamour mill in Timmins between 1981 and 1983.

The mine is about 15 km northeast of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	15.7	Junction; turn right (east) onto Chabot Road.
	27.7	Junction, in Saint-Joseph-de-Cléricy; continue straight ahead (east).
	28.7	Junction; turn right (south).
	32.0	Junction; turn right (west).
	32.3	Junction; turn left (south).
	38.0	LeRoy (Roybell, Claremont) mine.

Refs.: 4 p. 56–59; 70 p. 18–28; 83 p. 123; 144 p. 8–9; 365 p. 98–99.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
1463 South west quarter of Cléricy Township, County of Rouyn-Noranda (MRNQ, 1:12 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Vezina (Thurbois) mine

NATIVE GOLD, PYRITE, CHALCOPYRITE, GALENA, SPHALERITE, HEMATITE

In breccia

Native gold occurred as fine grains in the host breccia and as inclusions in pyrite. Chalcopyrite, galena, sphalerite, and hematite (specularite) occurred with pyrite in quartz veins.

A. Paquin of Noranda discovered gold-bearing quartz veins on the property in 1938. Thurbois Mines Limited explored the veins from a 85 m shaft in 1947. Exploration Aiguebelle Inc. outlined an orebody in 1980–1982 and mined it until 1987. Underground operations were from a 458 m shaft and a ramp. A mill operated on the site. Cambior Inc. continued operations from 1987 to 1989; production amounted to about 3 448 825 g of gold and 1 086 459 g of silver.

The mine is about 26 km north of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	28.7	Junction; turn right (east) onto Chemin du Parc.

35.9 Junction, in Destor; continue straight ahead (east) along Chemin du Parc.

44.4 Junction; turn left (north).

47.1 Vezina (Thurbois) mine.

Refs.: 4 p. 53–54; 152 p. 47–49; 155 p. 44–46; 456 p. 86.

Maps (T): 32 D/7 Cléricy
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
635A Cléricy, Abitibi and Témiscamingue counties, Quebec (GSC, 1:63 360)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

Duquesne mine

PYRITE, MAGNETITE

In quartz-feldspar porphyry

Gold was associated with finely disseminated pyrite. Magnetite was present in minor amounts.

Duquesne Mining Company Limited began development of the deposit in 1941–1942. Mining from a 381 m shaft began in 1945. Production between 1947 and 1952 amounted to 776 580 g of gold and 71 350 g of silver, from 80 872 t of ore.

The Duquesne mine is about 25 km north of Rouyn-Noranda. *See* Map 11 on page 68.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km 0 Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.

28.7 Junction, Chemin du Parc; continue north along Highway 101.

30.8 Junction; turn left (west) onto the mine road.

31.15 Duquesne mine.

Refs.: 101 p. 78; 118 p. 50–51; 257 p. 73.

Maps (T): 32 D/6 Rivière Kanasuta
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
825 Parts of Hebecourt, Duparquet, and Destor townships, West-Destor sheet, Abitibi-West County (MRNQ, 1:12 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000.

Central Duparquet mine

NATIVE GOLD, PYRITE, ARSENOPYRITE, CHALCOPYRITE, SPHALERITE, TETRAHEDRITE

In syenite

Native gold is associated with pyrite and arsenopyrite. Visible gold associated with chalcopyrite, sphalerite, and tetrahedrite was found in quartz veins during initial exploration.

George Kellar staked the deposit in 1924. In 1928–1929, Duparquet Mining Company Limited sank a prospect shaft to 15 m and another shaft to 59 m about 49 m farther east. The company worked the deposit until 1936. Between 1937 and 1939, Dumico Gold Corporation sank No. 3 shaft to 229 m on a new zone 800 m west of the original shaft. In 1941, Consolidated Beattie Mines Limited deepened No. 3 shaft to 305 m. The deposit is estimated to contain 200 000 t of ore averaging 6.2 g/t gold.

The mine is about 32 km northwest of Rouyn-Noranda and just east of Duparquet. *See* Map 12 on page 88.

Road log from Highway 117 at **km 96.9** (*see* p. 8):

km		
	0	Rouyn-Noranda, at the junction of highways 117 and 101; proceed northeast along Highway 101.
	34.3	Junction, Highway 393; proceed west along Highway 393.
	46.5	Trail on right, to the Central Duparquet mine. Follow this trail leading north for 300 m to No. 3 shaft. The original shafts are 200 m north of Highway 393, at a point 750 m east of km 46.5.

Refs.: 83 p. 96–97; 118 p. 47–48; 230 p. 101–104; 284 p. 49–51.

Maps (T): 32 D/11 Palmarolle
(G): 271A Rouyn–Harricanaw area, Abitibi and Témiscamingue counties, Quebec (GSC, 1:253 440)
823 Parts of Hebecourt, Duparquet, and Destor townships, West-Duparquet sheet, Abitibi-West County (MRNQ, 1: 12 000)
824 Parts of Hebecourt, Duparquet, and Destor townships, East-Duparquet sheet, Abitibi-West County (MRNQ, 1: 12 000)
2109 Carte géologique des gîtes métallifères des districts de Rouyn-Noranda et de Val-d'Or (MRNQ, 1:250 000)
M-308 Gîtes minéraux du Québec, région de l'Abitibi, feuille Rouyn-Noranda 32D (MRNQ, 1:250 000)

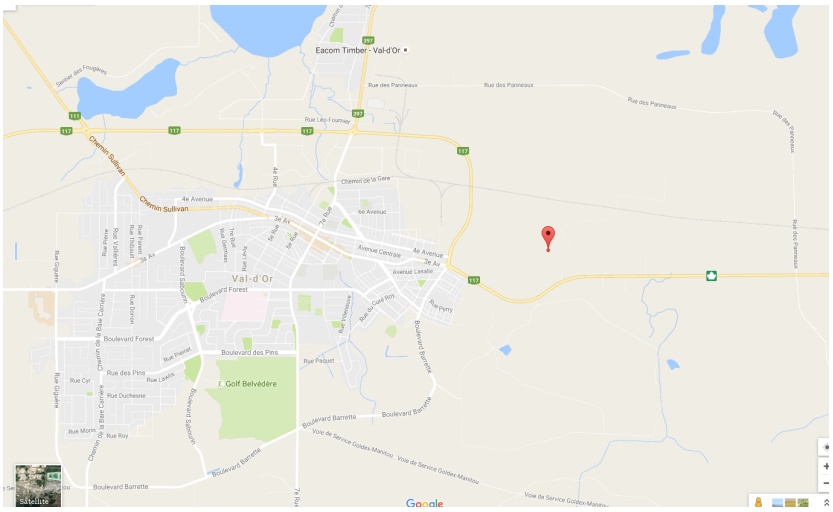
Beattie-Donchester mine

NATIVE GOLD, PYRITE, ARSENOPYRITE, MAGNETITE, LEUCOXENE, ILMENITE, MOLYBDENITE, CHLORITE, TITANITE, MICA, FLUORITE, TOURMALINE

In brecciated and silicified porphyry

Native gold occurred as very fine particles associated with finely disseminated pyrite and arsenopyrite. Magnetite, leucoxene, ilmenite, molybdenite, chlorite, titanite, green mica, fluorite, and tourmaline have been reported from the deposit.

Sigma mine: http://www.mindat.org/loc-22946.html 48.1013888889,-77.7547222222



Lapa mine: http://www.mindat.org/loc-257070.html 48.2277777778, -78.2663888889

But I think these are maybe working mines (stibnite, pyrites as mindat search criteria)

Original and additions

1] Extraction, sorting and earth processing.

1- Retrieving and digging out of minerals and ores for further processing: copper, gold, silver.

1-2- Making charcoal from wood.

1-2- Construction of a charcoal smelting furnace using earth, concrete (perhaps) and firebricks.

1- Breaking down, smashing, sorting and smelting ores in the field using the charcoal furnace.

1- Fire assaying/cuppelation - grinding and mixing of ores, heating with MAPP torch.

1- High heat thermite reaction for melting sand to silicon:

9 parts sand// 10 parts aluminium powder // 12 parts sulfur

2- Digging out of dissolution materials and minerals: weathered ferrous sulfate (iron pyrites).

2- Sourcing other dissolution materials: salt from lake/sea water - st lawrence, potassium nitrate/saltpeter from caves (bat guano), old horse stables.

2- Also sourcing and testing acidic water runoffs/ponds from any old mining operations

2- Simple tests of dry distillation of basic acids (nitric acid from saltpeter and pyrites, sulphuric from pyrites and hydrochloric from salt and pyrites).

1-2 And observation of their potential dissolving operations on 1- ores

2] Refinement and recrystallisation

In workshops and working residency/process.

1- Melting of metals and ores using blowtorch and attempts to re-purpose these into logical structures, simple computing elements.

2- Extraction and re-crystallisation of dissolution materials outlined above: processes of grinding, dissolving and evaporating over long periods of time and moderate heat.

2- Dry, high heat distillation of acids towards the production and testing of Aqua Regia (nitric acid and hydrochloric acid - a solution which is able to dissolve gold) produced from collected materials above (this would involve either a charcoal furnace with fume issues or an electric heat source). Tests are first made on a small scale using test-tubes of materials, and blowtorch. Fumes are dangerous - so either in a well-ventilated space or outside

1-2- Tests on the mineral/gold dissolution of junked hardware - CPUs and memory.

2- Research and beginning modelling of cycling processes below. Also as to how the logical structures and technological elements can feed back into assisting in their own ouroboric self dissolution

3] Recycling/dissolution

Preparing for the exhibition. = 1+2

Infrastructure

- Construction of a fume hood/container/vitrine for the extraction of fumes during high heat processing and acid distillations
- Glass or piped connections between stages of re-modelling of cycling processes below

Re-modelling and refinement

- Modelling of the weathering of pyrites by bacteria (Thiobacillus Ferrioxidan) in rain water flows within a stacked/digester assembly of glass.
- Small model of saltpeter farming processes using straw, horse manure and urine perhaps within some kind of aerated concrete vessels.
- Of cycles of evaporation and recrystallisation for salt and saltpeter. Again a series of glass dishes could be used.

Dissolution

- Remodelled processes above are combined (piped through) and distilled under high heat (how to do this safely is a question for earlier research) to produce a slow drip of Aqua Regia for the dissolving of a small pile of consumer electronics.

Returning to the earth

As some kind of final ritual or performance field trip gold and trace elements extracted from technological cycles are returned to the earth to enact a new circuit.

Overview

Making charcoal

Metal container with hole in top and loose fitting lid.

Put small hardwood pieces into container.

Put container-full with lid on into hot fire.

Flammable methane comes out of hole in lid - light it.

Charcoal is ready when this flame no longer burns.

Remove from fire, let cool and THEN remove the lid.

Mineral ores

Common ores:

Metal	Oxide	Sulfide	Carbonate	Sulfate
Iron	Hematite	Pyrite	Siderite	Green Vitriol
Copper	Cuprite	Chalcocite	Malachite	Blue Vitriol
Antimony	Senamontite	Stibnite		

updated 10/06

GeoMan's Mineral Identification

Minerals: Metallic Luster

Generally with a colored streak, opaque

Click here for sub-metallic minerals

Metallic | **H<2.5** | **H 2.5 to 3.5** | **H 3.5 to 5.5** | **H >5.5** | **Glossary** | **Tests** | **Index**

Rock Summary | **Igneous** | **Sedimentary** | **Metamorphic**

STREAK	HARD	COLOR	REMARKS	NAME
Black	1	Steel gray	S.G. 2.0 Basal cleavage; Soft, marks on paper, greasy feel. Used in lubricants, and as the "lead" in pencils.	**GRAPHITE**
Iron-black	1-2	Black	S.G. 4.8 Radiating fibers, granular masses, or dendritic; sooty. An ore of manganese.	**PYROLUSITE**
Yellow brown	1 to 5	Yellow brown to black	S.G. 3.3 to 4.0 Your basic rust, limonite forms whenever and wherever iron is exposed to oxygen. Many forms and lusters. Occurs as flattened crystals, massive, reniform, or stalactitic. Common secondary mineral in rocks and soils. An important ore of iron.	**LIMONITE**
Red brown to Indian red	1 to 6.5	Steel gray	S.G. 4.8 to 5.3 Many forms and lusters (can also occur in sub-metallic to non-metallic forms). Can be massive, radiating, botryoidal, and micaceous. The crystalline (metallic and sub-metallic) varieties are generally harder than the earthy (non-metallic) varieties. An important ore of iron.	**HEMATITE**
Gray	2.5	Gray	S.G. 7.6 Perfect cubic cleavage (3 @ 90°); Occurs in cubes; may be massive or granular; feels heavy. The most common ore of lead.	**GALENA**
Light gray to silver	2.5	Silvery white, tarnishes to black	S.G. 10 to 12 Hackly fracture, easily distinguished from galena by lack of cleavage. Malleable and ductile. Used in coinage, fillings for teeth, jewelry, silverplate, photography, wires.	**SILVER**
Yellow	2.5 to 3.0	Pale to golden yellow	S.G. 19.3 Hackly fracture. Malleable and ductile. Used in coinage, fillings for teeth, jewelry, goldplate. Extensive use in computer industry as non-corrosive contact points for silicon chips.	**GOLD**
Gray to black	3.0	Bronze, tarnishes to dark blue and purple	S.G. 4.9 to 5.4 Commonly called "peacock ore" because of the purple shine when it tarnishes. A common source of copper.	**BOURNITE**

Copper red	3.0	Copper red	S.G. 8.5 to 9.0 Malleable and ductile. Used in coins, pipes, wires, gutters, cooking utensils, pots and pans, jewelry, decorative items.	**COPPER**
Greenish-black	4	Brass yellow	S.G. 4.3 The distinctive buttery yellow color is often tarnished purple or gray; more yellow and softer than pyrite. An ore of copper.	**CHALCO-PYRITE**
Chocolate brown	5.5	Black to dark brown	S.G. 4.6 Distinctive chocolate brown streak. Commonly occurs as stratabound deposits in dunite segregations in ultramafic rocks, and as podiform masses in serpentinite. Used in stainless steel, high temperature alloys, and as refractory bricks. The ore of chromium.	**CHROMITE**
Black	6	Black	S.G. 5.2 Conchoidal fracture. Strongly magnetic. Often called "lodestone." Common accessory mineral occurring as disseminated grains in mafic igneous rocks. An ore of iron.	**MAGNETITE**
Black to greenish	6	Pale brass	S.G. 5.0 Often in cubic crystals. Can be massive, granular. Common name: "Fool's gold." Commonly alters to limonite. Sometimes mined as a source of sulfur.	**PYRITE**

Minerals: Sub-Metallic Luster

STREAK	HARD	COLOR	REMARKS	NAME
Yellow-brown	1 to 5.5	Yellow to dark brown	S.G. 3.3 to 4.0 Your basic rust, limonite forms whenever and wherever iron is exposed to oxygen. Many forms and lusters. Occurs as flattened crystals, massive, reniform, or stalactitic. Common secondary mineral in rocks and soils. An important ore of iron.	**LIMONITE**
Red brown to Indian red	1 to 6.5	Red, vermillion	S.G. 4.8 to 5.3 Many forms and lusters (can also occur in sub-metallic to non-metallic forms). Can be massive, radiating, botryoidal, and micaceous. The crystalline (metallic and sub-metallic) varieties are generally harder than the earthy (non-metallic) varieties. An important ore of iron.	**HEMATITE**

Metallic | **H<2.5** | **H 2.5 to 3.5** | **H 3.5 to 5.5** | **H >5.5** | **Glossary** | **Tests** | **Index**

Rock Summary | **Igneous** | **Sedimentary** | **Metamorphic**

GeoMan's Home Page | **RCC Index** | **High School Geology Index**

Preparing (from The Way of the Crucible)

- Crush and grind ores to a powder
- Hard stones can be heated then thrown into cold water
- Getting rid of impurities such as arsenic, mercury, cadmium, selenium, zinc and free sulfur: roasting outside for a day or two at 90C. Stirring now and again. Raise to 250C for another day or 2.
- Conversion of common ores to oxides by further heating. Powdered ore is calcined at higher temperatures, ground and calcined again
- Sulfide and sulfate minerals are treated this way to get rid of sulfur and replace with oxygen to form oxide
- Carbonate minerals calcines to oxide with the release of carbon dioxide - also soluble in acidic solutions and form the salt of the acid (eg. nitrates from nitric)
- Low grade minerals can be purified in mineral acids such as nitric or hydrochloric acid which separates metal from silicon or alumina matrix. Acid solution is then neutralized with sodium or potassium carbonate in solution. This forms carbonate of the metal which precipitates at bottom

Metal ore images/ID

Hematite/magnetic:

Hematite has an extremely variable appearance. Its luster can range from earthy to submetallic to metallic. Its color ranges include red to brown and black to gray to silver. It occurs in many forms that include micaceous, massive, crystalline, botryoidal, fibrous, oolitic, and others.

Even though hematite has a highly variable appearance, it always produces a reddish streak.

Stibnite:

copper ores: chalcopyrites (copper iron sulfide):

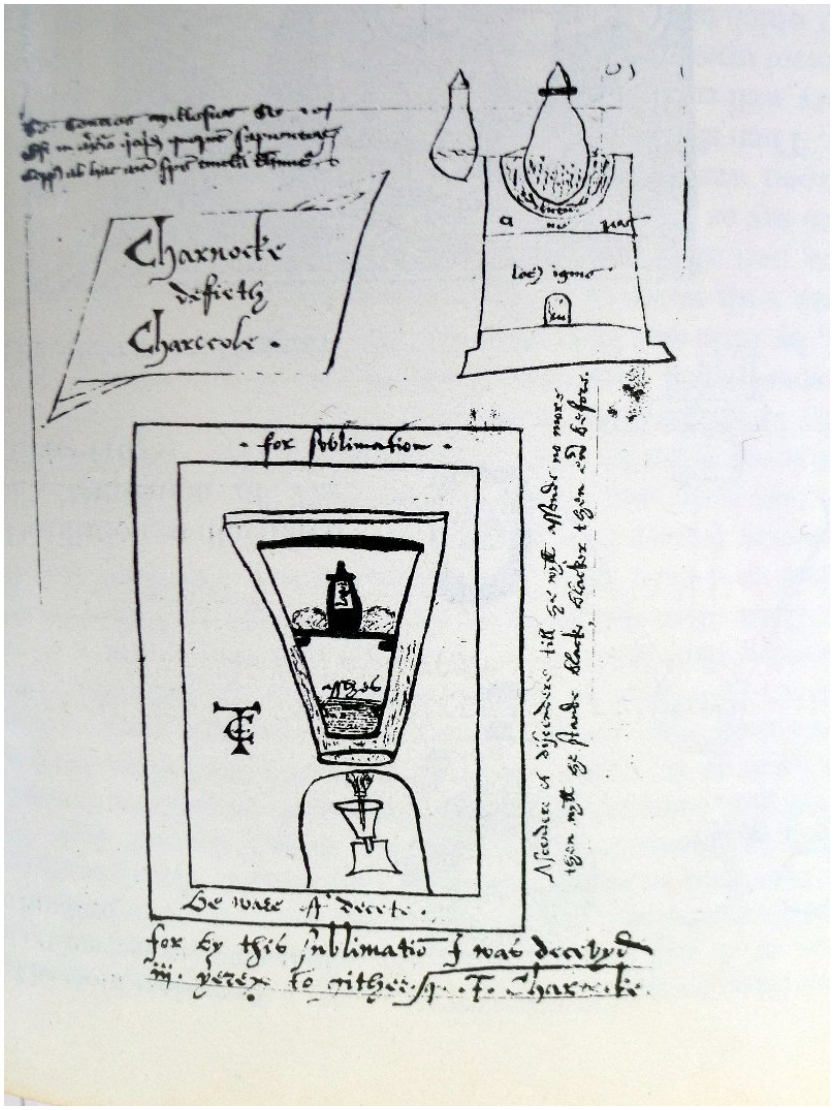
malachite (copper carbonate):

Notes:

Chalcopyrite is copper/iron sulfide

Effervescence (the Fizz test): Minerals containing calcium carbonate (CaCO3) will generally react when exposed to weak acid (usually hydrochloric acid (HCl), but even vinegar will work). Carbon dioxide (CO2) is released and the mineral or rock literally "fizzes." Some may need to be powdered (increases surface area) before any reaction can take place.

Furnace, ores and assay



Reconstructing and testing the Pentrwyn pit furnaces.

Late Bronze Age copper smelting on the Great Orme.

DA Chapman RCA &

SG Chapman MA AIFA,

Ancient Arts 2013

Pentrwyn Bronze Age copper smelting site: Reconstructing and using the Pentrwyn pit furnaces

DA Chapman RCA & SG Chapman MA AIFA ***Ancient Arts***

Summary

Evidence for small-scale copper smelting dating to the Bronze Age has been identified at Pentrwyn, Great Orme. This evidence was in the form of copper smelting debris (copper metal and slags) and three very small pit features. This short paper examines the evidence; records our successful attempt at reconstructing the pit features as small, assaying furnaces and briefly discusses the implications of the results.

Introduction

In 1997, David Chapman of Ancient Arts identified eroding deposits on the Great Orme, Llandudno. These deposits contained fragments of charcoal, shells, bone and metal working debris in the form of small, prills of copper metal (less than 50mm in diameter) with adhering fragments of slag like material. The potential importance of this site was significant as it is located just over one kilometre from the remains of the most extensive Bronze Age copper mine known in the UK. At the time of its discovery and subsequently no associated smelting sites or settlement sites have been found on the Great Orme. Indeed, no Bronze Age smelting sites have been positively identified in the UK.

As a result Cadw funded Gwynedd Archaeological Trust to undertake two excavations (one in 1998 and one in 2011) to recover any surviving remains. A third 'rescue' excavation was undertaken in 2005 by the authors to record and recover information exposed by an episode of severe erosion.

The site seen from the road. The excavations took place on the top terrace. Note the erosion of material.

All that was left of the original terrace, with the road below.

The site itself had been severely damaged in the 19th Century by the construction of a tourist route, The Marine Drive. This road running around the Great Orme's Head had removed 80-90% of a natural limestone shelf on which the site was located. As a result only a small, rectangular area of approximately 4m by 2m remained in 1997. The eastern side of this area was exposed as a section of deposits overlaying limestone bedrock. It was from this section that the charcoal and metal working debris were eroding. Natural erosion was destabilising this section and in addition sheep and goat activity and use by rock climbers was causing further erosion of the surface above the section.

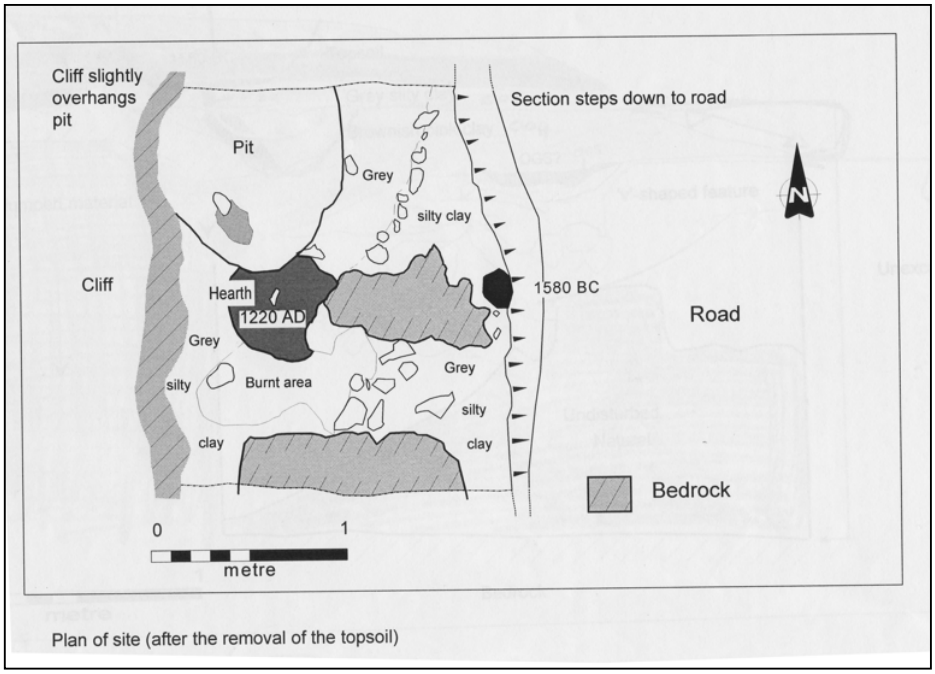
Below is a brief description of the results of the excavations.

The 1998 excavation

This excavation removed an area of 2.2m by 1.8m down to the buff coloured clay that was found across the whole site.

The site under excavation in 1998, the Medieval or later pit is visible in the bottom right. Scale 2*1m.

This was overlain by a grey silty/clay (Context 020/028) which contained fragments of animal bone, pieces of metallurgical debris and copper ore. A fragment of shale bangle was also recovered from this layer. The largest feature recorded was a pit (025) which contained fragments of burnt stones, animal bones, marine shells and a whetstone. This pit cut both the grey silty clay layer and the buff coloured clay. It also cut was therefore later, another charcoal rich, shallow pit (031) the lower fill of which produced a radio carbon date of cal AD 1035 – 1285 at 95% probability (Beta-127077) (Hopewell & Jones 1999).



Plan of site (after the removal of the topsoil)

The remains of the hole/pit filled with charcoal rich silt and metallurgical material dated to the Early/Middle Bronze Age.

Seen first in section before excavation (scale 0.2m) and below in plan (marked by the tag) before excavation.

The whetstone (below) found showed several wear patterns, suggesting different uses. Its larger flat surfaces and the side edges show evidence of polish (indicating its use as a whetstone); while the short end edges and the corners show evidence of it being used to hammer and crush some hard material. In places this evidence had been partly worn flat by its re-use as a whetstone. Although this was found in the later pit (025) it might be residual from the earlier layers as the pit clearly cut both the grey silty clay and the buff clay layers.

The whetstone showing battering marks at all corners.

The whetstone: showing crushing and battering damage on ends and edges.

Metallurgical debris was found across the site in all layers excavated. These were sent to The Department of Materials, University of Oxford for analysis. (A full discussion of the results follows the descriptions of the excavations.)

An example of the small size and appearance of the metallurgical debris recovered from the site.

The 2005 excavation

Erosion of the site in 2005 - note the exposure of the netting that covered the 1998 excavated area. The 'rescue' excavation took place immediately above the scale. Scale 1m.

In October 2005, it was noticed that the grey layer identified in 1997 was exposed at the northern, unexcavated end of the site. It contained fragments of reddish clay, charcoal and slag/copper metal material. To prevent the unrecorded loss of this material a small area (c.1m by 0.5m) was cleaned and the metallic debris recorded and removed. This material was found to be eroding out of the grey silty layer identified covering the area excavated in 1998 which produced most of the metallurgical debris.

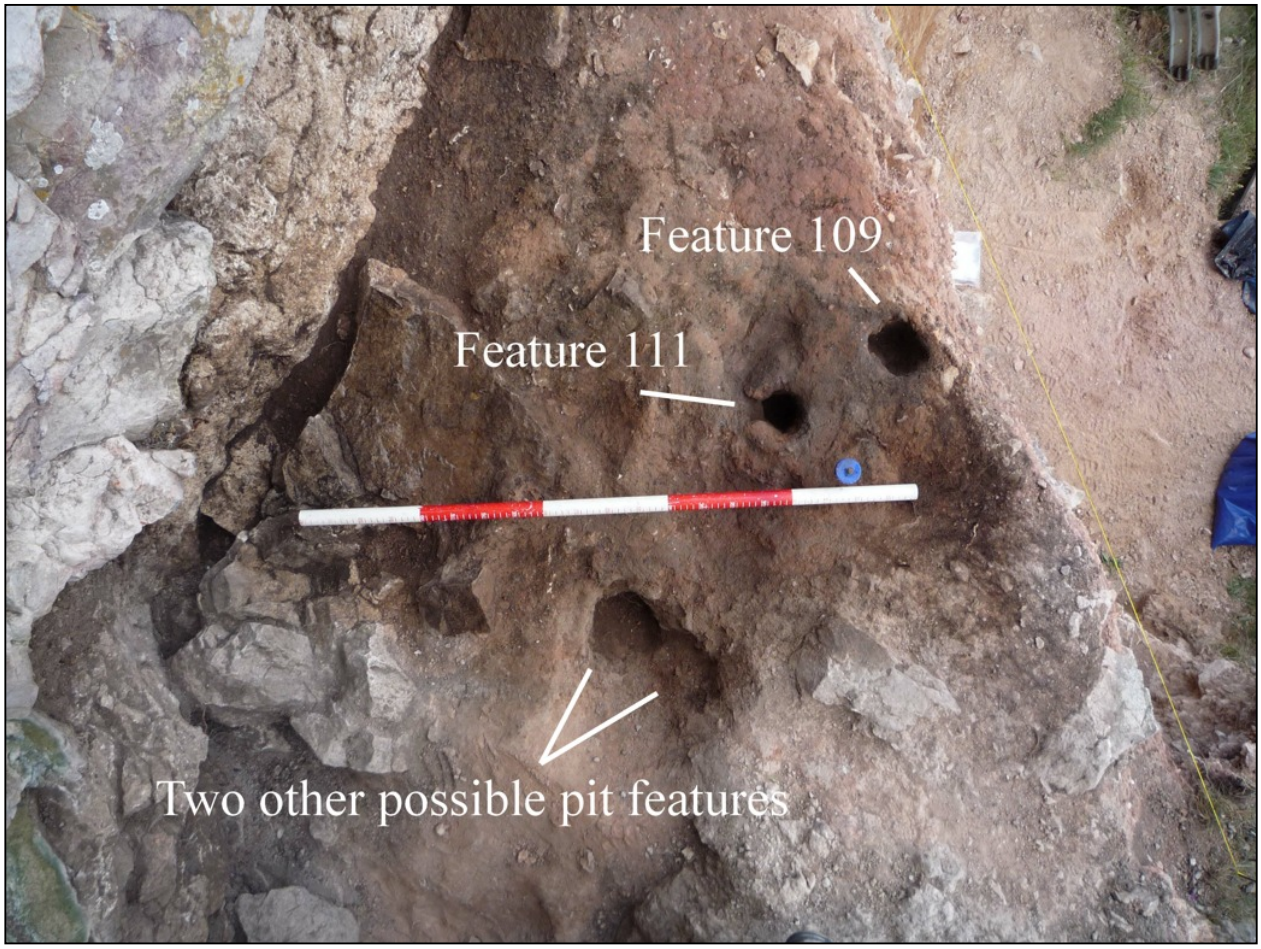
A distinct patch of yellow silty clay was also identified overlaying the grey silty layer on the western side of the area excavated. This feature was cut by the large post AD 1220 pit (025) found during the 1998 excavation but not fully excavated (Hopewell and Jones 1999). The yellow clay in turn overlaid a small sub-circular feature (later identified as pit 111). This small pit was only partially exposed during this excavation. A second small sub-circular feature was found 100mm to the east of the first (later identified as pit 109). This was fully excavated and the fill retained. Both small pits contained fragments of metallurgical debris; which were retained for analysis. No further excavation took place and the area was recovered with material.

The patch of yellow silty clay cut by the unexcavated Medieval or later pit (on the left). Scale 0.2m.

The two pits 109 and 111 (Pit 111 was only partly exposed and not fully excavated at this time). Pit 111 was overlain by the patch of yellow silty clay. Scale 0.3m.

The 2011 excavation

With erosion of the site continuing, in 2011 Cadw funded a second excavation of the remaining deposits. Ancient Arts Ltd undertook 'on site' and later 'off site' wet sieving of all the material excavated on the site. This excavation recorded the two small pit features (109 and 111) in further detail. These features were sub-circular in plan, almost vertically sided but tapering slightly at the base. Feature 109 was 100mm in diameter and 100mm in depth and Feature 111 was 90mm in diameter and 150mm in deep (Smith 2012, 5).

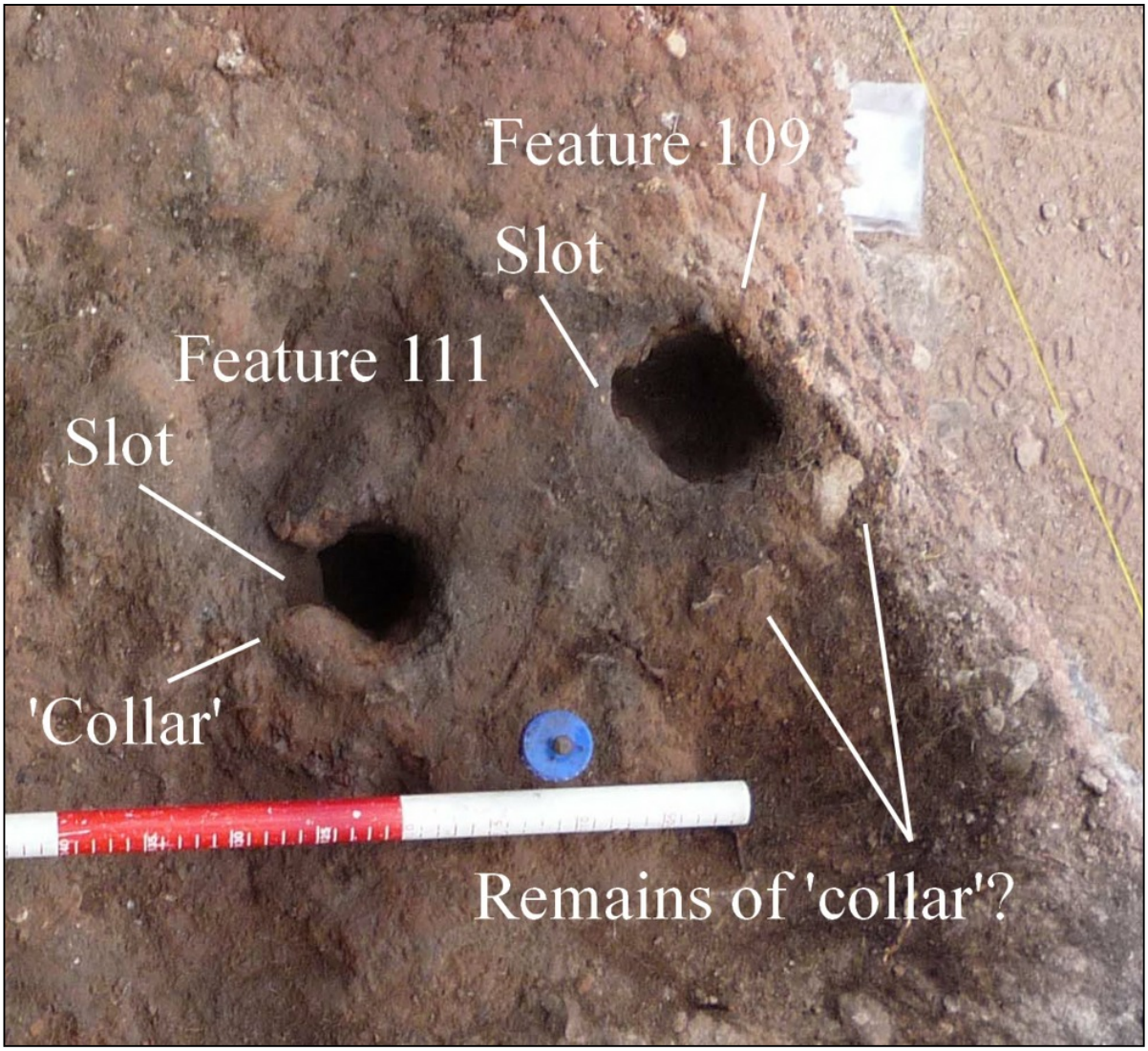


View from above showing the location of the two pit features 190 and 111 and two other possible pit features. Scale 1m.

Feature 109 had a notable slot cut into the top of the cut (on the west side) which gave it an unusual *keyhole* appearance. Feature 111 also had a similar *keyhole* appearance and in addition had a modelled raised rim or *collar* around an its top with a gap or slot cut into its western side. (see below). Feature 109 lacked a definite *collar* but it had suffered greater damage from erosion than Feature 111. Feature 111 had also been sealed and protected by a distinct light coloured patch, Context 129, whereas the top of Feature 109 had already been partly exposed when the 2005 excavation took place (Chapman and Chapman 2005). However, a surviving arrangement of stones around the south edge of 109 may represent the remains of a clay *collar* (see below).

The fills of the pit features were slighter darker and more charcoal-rich than the general layer (Context 108) into which they were cut and a number of copper metal prills had been retrieved from them when they had first been exposed in 2005. Charcoal from the fill of pit 109 produced a radio carbon date of 930-809 cal BC with a 94.6% probability (SUERC-44867). (Two other date were obtained for the grey silty layer just to the west of the pits; they were 929-812 cal BC and 1005-842 cal BC (Smith *pers com*).

Reconstructing and testing the Pentrwyn pit furnaces.



A close-up of Features 109 and 111, showing the slots and 'collar' feature.

Initially, due to their small size and lack of evidence for exposure to high temperatures, the features were not identified as possible furnaces. However, previous experimental work smelting copper in bowl furnaces has shown that the archaeological evidence which might be expected to be found, such as burnt clay or vitrified soils, were often not produced by small-scale experimental furnaces (Chapman *pers. com.*). Also, the original metallurgical analysis undertaken after the 1998 excavation (Northover & Salter) concluded that the smelting on the site was small-scale, perhaps assaying rather than large scale smelting.

With this evidence in mind we undertook a series of experiments to test if these features could indeed be the remains of small assaying furnaces.

Methods

There is very little archaeological evidence of copper smelting in mainland Great Britain from before AD1500. However, previous experimental work has shown how it is possible to smelt carbonate ores using bowl or pit furnaces, clay tuyeres and leather bag bellows (http://www.youtube.com/watch?v=8uHc4Hirexc). So using this previous work as a starting point we set out to reconstruct the Pentrwyn features (pits 109 and 111) and then attempt to smelt copper with them. (Not enough of the Early to Middle Bronze Age pit found in 1998 survived to reconstruct to include in this project.)

The ore

One of the most important elements involved in this experimental project was to ascertain the type of copper ore that was being smelted at Pentrwyn. This is important as primary sulphide ores and secondary carbonate ores are smelting slightly differently. Sulphide ores are *roasted* first to burn off impurities and a flux such as quartzite, feldspar or limestone is used in the smelting process. Carbonate ores do not require pre-smelting *roasting* or a flux and can be smelted at relatively low temperatures.

Analysis of the original metal working debris found in 1998 was based on only 18 small fragments from the site. The condition of the material was described as '*not good, as it has suffered from 3500 years of corrosion aided by salt spray*' (Northover and Salter, 2). Also the small size of the individual pieces meant that in some samples '*only very limited areas of material*' *(*Ibid*.)* were suitable for analysis. The samples contained slag material, fragments of copper ore and fragments of metallic copper.

Using lead isotope analysis Northover & Salter felt that they could make a direct connection between the fragments and the Great Orme. High concentrations of uranium and thorium are found in the minerals of the Great Orme and this was indeed the case from the Pentrwyn samples, so that '*within the limitations of available lead isotope data'* (Ibid., 9) they felt that the copper prills from Pentrwyn could be linked to the mineralisation of the Great Orme.

The slag was described as '*inhomogeneous*' in nature suggesting that the '*charge within the hearth/furnace never became fully fluid*' (Ibid., 8). So the metallic copper was only partly smelted and not refined into its massive form. Hence it was found as small prills and not as a large conjoined mass. Northover & Salter (Ibid*.,* 8)agreed with Hopewell and Jones that these copper prills/slag fragment could then have been crushed (removing much of the slag material and re-smelted to form purer, larger fragments).

The high proportion of copper sulphides present in both the metal and slag together with the remnant ore fragments, '*indicate that the ore used was rich in sulphide mineral*' (Ibid., 8) and derived from chalcopyrite. However, the primary ores exploited on the Great Orme were carbonate ore such as malachite. Dutton & Fasham have suggested that high-quality carbonate ore were exploited during the Early Bronze Age 1885-1465 BC and 1735-1440 BC (Dutton & Fasham, 1994, 284). They argue that these could have been smelted at relatively low temperatures and would have produced minimal amounts of slag. They go on to suggest that later re-working of the mines (1428-975 BC) was

However, the metallic debris from the 1998, 2005 and 2011 excavations consisting of over 500 fragments is currently being analysed by Alan Williams (University of Liverpool). Whose current assessment is:

The current evidence suggests that predominantly oxidised ores were mined during the Bronze Age at the Great Orme mine. The principal ore minerals would have been malachite with occasional azurite, usually mixed with substantial amounts of goethite (hydrated iron oxide containing some copper), all derived from extensive weathering of the primary chalcopyrite mineralization. Other minerals present include calcite and dolomite. However, in some areas of the Bronze Age workings, particularly in the harder sides of the veins there would have been some residual unconverted chalcopyrite within the oxidised ores. The occasional traces of sulphide minerals found in the Pentrwyn smelting residues may just reflect this situation rather than indicating that sulphide rich ores were being smelted.

(R A Williams *pers. com.*)

As fragments of malachite ore were visually identified at the Pentrwyn site during the excavations and that the recent metallurgical analysis is based on a much larger sample than Northover and Salter examined indicates that malachite (containing residual unconverted chalcopyrite within the oxidised ores) was most likely smelted at Pentrwyn it was decided that malachite would be smelted during the experiments.

The tuyère

A simple *tuyère* was made from a mix of clay and chopped plant fibre (dung could also have been used). It was then dried on a small fire . Previous experimental work has shown that it is **not** necessary to partially fire or even fully fire the clay so that it becomes a true ceramic.

The dried tuyere.

The diameter of the *tuyère* was determined by the width of the slot from the Pentrwyn features. This was approximately 50mm which allowed for a diameter of approximately 15mm for the internal air channel.

The internal air channel.

A pit was then excavated 100mm in diameter and 110mm in depth. This was found to be the smallest hole it is possible to excavate easily with your hand. Any smaller and it becomes difficult to remove the fill.

Excavating the pit. Scale 0.2m.

A small slot was then dug entering into the pit on one side. This was to allow the *tuyère* to enter the furnace (and give the pit a distinct *keyhole* shape similar to those recorded at Pentrwyn). Its depth was determined by the evidence from Pentrwyn where the slot did not continue straight down the side of the pit but was only visible near the top of the pit.

The excavated pit with tuyère slot and the tuyère itself. Scale 0.2m.

The fill of the excavated pit was then mixed with water and used to form a *collar* similar to the one identified on Pentrwyn Feature 111. It became clear that this *collar* not only helps hold the *tuyère* in place but most importantly allows the furnace and the tuyère to be sealed when the *turf cap* is placed on top. Once working the whole furnace, including the *tuyère*, has to work as a pressurised system to smelt the ore. This *collar* acts as a washer between the top of the furnace and the *turf cap*. Without this seal it is very difficult to produce a *back pressure* within the furnace and without this *back pressure* the temperature within the furnace would level off before it reached the temperatures needed to smelt the copper.

Making the 'collar', note the turf cap in the background and the kindling ready to start the smelt.

The angle of the *tuyère* was determined by the shallowness of the slot from Pentrwyn Feature 111. We had initially intended to use leather bag fellows to fire the furnace, but these are usually laid on the ground horizontally to the furnace and after a number of readjustments it became clear that the *tuyère* would have to enter the pit at a steep 60 degree angle. At this angle bag bellows would not work and it also became clear that the bag bellows would produce far too much draft for such a small furnace. This led us to the conclusion that a blow pipe was a more likely source of air for the original furnaces.

The steep angle of the tuyère entering the furnace.

Therefore, we decided to use a blow pipe to draft the furnace. Wooden blow pipes can easily made from straight pieces of elder branches which have been split open, the pith removed and tied back together leaving a long, hollow tube. Clay was then added to the mouth of the tuyère to form a seal to help pressurise the system.

Using a blow pipe.

Malachite ore was then crushed to dust using a stone hammer and mortar and the furnace lit using a kindling of twigs (birch) with charcoal added. Subsequently some of the charcoal fragments from the 2011 excavation of pit features from Pentrwyn have been identified as holly, this would have made ideal kindling (Smith pers com).

The blow pipe in action.

Using the blow pipe the charcoal was set alight and a *turf cap* (simply a piece of cut turf) placed over the furnace. Turf makes an excellent refractory insulating material because it can withstand high temperatures and works just like *ceramic fibre* in a modern foundry.

During the 2005 excavation of the site a discrete, light coloured context (129) was recorded sealing Feature 111, excavated and retained. This was identified as a piece of possible buried turf perhaps representing the remains of a *turf cap*.

The crushed ore was added by hand onto the red hot charcoals and the smith started rhythmically blowing down the pipe. Now that the furnace is sealed by the *turf cap* this allows the smith to build up and control the pressure inside the furnace and therefore to control both the atmosphere and the temperature. It was observed that when using the blowpipe it was possible to physically feel the pressure changes within the furnace (from the resistance during blowing).

Interestingly it was also noted that the rhythmic blowing produced a feeling of euphoria and light headiness in those using the blowpipe!

The copper ore at the start of its journey down through the reducing zone of the furnace.

The small size of the furnace meant that a only comfortable and sustainable amount of air had to be blown into the furnace to produced the required pressure. Therefore, the size of the furnace matched the lung capacity of a single smith. To control the pressure within a larger furnace would have required more than one blow pipe or a larger set of bellows, such as a bag bellows. So this size of furnace was designed for a single blow pipe as the physical remains of the single slot suggested.

The smelt under way. Note that the ore has now moved down into the hottest part of the furnace.

Smelting with the 'turf cap' in place.

The smelt continued for 90 minutes with small amounts of further charcoal added when required. The charcoal is regularly tamped down to compact it and thereby reduce any air voids present. Wet charcoal and charcoal dust are also added. These factors created a *reducing atmosphere* (a carbon monoxide rich atmosphere) within the furnace which is needed to smelt the copper ore. In simple terms smelting takes place when the carbon monoxide produced by the burning charcoal bonds with the oxygen in the ore, this produces carbon dioxide and copper metal.

It is possible to see when this *reducing atmosphere* has been achieved. By removing the *turf cap* the flame from the furnace will have changed from a yellow/orange appearance to a purple/oily flame. This is called a *sick flame*.

After 90 minutes the contents of the furnace were then carefully removed and washed.

The contents of the furnace are removed by hand ane removed by hand and washed.

Small metallic copper prills are visible, some metallic material is still adhering to slag. Also visible are fragments of the kindling reduced to charcoal but still identifiable as small twigs.

Small metallic copper prills were quickly visually identified and retrieved. Some were adhering to slag fragments (which could have been partly removed by crushing). The assemblage of metallic debris and prills were visually very similar to those found at Pentrwyn.

Copper metal that has started to become fluid will form small prills. To test at what stage the other ore/metal was at we crushed the material with a stone. If it was only partly smelted (known as *blister copper*) it will be reddish in colour but will fracture like a heated stone. If this was the case it could be simply returned to the furnace and the smelt be continued for a further half hour. If it does not crush easily or fracture then the material is copper metal and the smith knows that has smelted a suitable copper ore.

The whetstone found in 1998 (in the later, post AD 1220 pit but possibly residual for the earlier Prehistoric activity) does have clear evidence of having been used as a hammer and as a pestle, to crush some hard material. This could have been used for crushing the ore at the beginning of the smelt or perhaps to break up or test the metallic material at the end of the process.

Results and discussion

The furnace

The furnace after the smelt with associated debris. Scale 0.2m.

Once it had been emptied the interior of the furnace was examined. There was no vitrification or reddening of the soil sides of the pit. Some charcoal fragments remained inside the pit and littered the area immediately around the furnace forming a dark, dirty *working floor* (very similar to the grey layer associated with much of the metal working debris at Pentrwyn). Fragments of copper ore dropped during the charging of the furnace were identified around it, as were small copper metal prills/slags where having been missed during the initial visual retrieval process. Again this reflects the debris from the *working floor* (grey layer) at Pentrwyn.

The *collar* remained intact, with some minor damage where the *tuyère* was removed. Although this is essentially just dried soil and is therefore quite delicate replacing the turf cap after use (as what appears to have happened at Feature 111) would protect this delicate feature very well.

Features 109 (top right) and 111 (bottom left) showing the tuyère slots and collar. Scale 0.2m.

Reconstructed pit furnace after the smelt. Scale 0.2m.

The tuyère

At the end of the experiment the *tuyère* was also examined. The end at which the blow pipe entered had suffered some damage (this occurred during a personnel change over on the blow pipe) but his had been quickly repaired with some wet clay. The furnace end had small amounts of vitrified soil/charcoal adhering around its very end (where it would have been resting in the hottest part of the furnace). This end also appears to have been partly fired by the heat within the furnace and is harder than the rest of the *tuyère*.

The reddened and slightly vitrified furnace end of the tuyère. Scale 0.2m.

As part of the on-going experiment it was left on the ground near the abandoned furnace. Within two weeks it began to noticeably deteriorate with mould appearing on the surface and this showing signs of structurally decaying. It is anticipated, based on previous experiments that most of the *tuyère* will disintegrate quite quickly leaving just the small part of the semi-fired end, which itself may deteriorate into smaller fragments.

The turf cap showing signs of burning and drying. Note the green copper ore debris in the centre and part of the damaged tuyere on the left.

The turf side of the *turf cap* showed no visible signs of heat damage. While the under side showed signs of burning and drying (to a depth of 25mm) but no sign of any soil vitrification.

Future analysis needs to be undertaken on this *turf cap* and on Context 129, the possible buried turf found in 2005 at Pentrwyn, to determine if either or both are heavily contaminated with the chemicals or trace elements associated with the smelting process. It would also be very valuable to examine Context 129 for the presence of any charred root remains.

It is interesting to note that environmental evidence from the 1998 excavation identified the presence of charred *Poacea* (grass) remains, including rhizome material (Caseldine and Barrow, 2). These came from the fill of the post AD 1220 pit (Context 25). However, it was felt that *'...some, if not all of the remains, are possibly residual and prehistoric in date'* (Ibid. 1). The 2005 excavation showed that this pit (Context 25) cut the possible buried turf cap (Context 129) and therefore the charred grass rhizomes may indeed have originated from this earlier context.

The light coloured Context 129 as exposed during the 2005 excavation. It sealed Feature 111. Note Pit 25 cuts 129.

The furnace pit was backfilled using the debris in the immediate vicinity, the *turf cap* placed over it and left. It is intended to continue to monitor and record its decay.

Conclusions

This experiment has shown that the two pits found at Pentrwyn can work perfectly and elegantly as small-scale assaying furnaces. The physical evidence from the excavations: the size of the features, the remains of the *collar,* the *tuyère* slots, the possible remains of the *turf cap,* the whetstone and the metallic debris all compellingly point to the pit features being small-scale assaying furnaces. The experimental work has also shown that features often expected to be found on smelting sites such as vitrified clays, crucibles and large amounts of slag material would not have been produced or needed on this particular activity.

As assaying furnaces they are efficient and very well designed. The presence of the *collar* shows that the smith understood the need to seal the furnace to build up and maintain the internal pressure of the furnace to smelt the ore. If the intention was to test the ore, to ensure that it was copper ore or that it was of suitable quality, then there would be no reason to smelt any more ore than necessary to ascertain this. These furnaces could be worked by a single person, would use very little charcoal (0.9 litre of charcoal was used during the experiment) and could be done relatively quickly and discreetly.

The metallic material produced by the experiments closely mirrors the metallic remains found at Pentrwyn and indicate that full, fluid smelting of copper ore was not undertaken on this small part of the site excavated (baring in mind that most of the original shelf on which the site was located was destroyed in the Nineteenth Century and the full extent of the original site is not known). The fact that so many copper prills were left on the site suggest that the smith was more concerned with the assessing the quality of the ore (or indeed if it was ore) rather than retrieving as much metal as he could.

The lack of obvious and severe heat alterations to the soil forming the furnaces, the lack of surviving crucibles and *tuyères* may have broader implications for the future identification and excavation of low temperature copper smelting furnaces. Previous experimental work using large, repeatedly fired earth and dung *above ground* furnaces to fully smelt carbonate copper ores has shown that once abandoned and left exposed to the weather they will completely dis-integrate and wash back into the ground leaving only a few very small fragments of reddish clay and charcoal within period of a year. Careful retrieval of the metallic copper produced by these furnaces using visual identification and a simple *panning* technique of furnace contents leaves very little accidental loss of copper metal (it is even possible to retrieved and re-use any remaining charcoal). It cannot be over emphasised that the Pentrwyn site was only identified as a smelting site because of the careful retrieval of very small metallic debris from wet sieving every bag of soil excavated. Only a few pieces of this debris were identified by eye during excavation and this only after the excavators were made aware of its probable presence.

In addition to Features 109 and 111 there were the possible remains of two other furnace pits (both badly damaged or destroyed) just to the south-west (see illustration 1) as well as, the remains of Feature 021 (dated cal BC 1580) from the original 1998 excavation which may also have been the remains of another small furnace. Are we looking at an assaying site that was regularly re-visited over a long period of time and not a one off event?

The location of the site also hints as its use as an assaying site. It is located well away from the Bronze Age mines at Pyllau. (To the North of the site is the copper ore *washing site* at Ffynnon Galchog/Porth yr Helig. However, the one date from this site is cal AD 720-740 and 680 – 960 (Lewis 1993, 10) and therefore, not contemporary with Pentrwyn.) You would expect an assaying site to be located near to the ore source. It is possible that there is an as yet unidentified Bronze Age mine near the site, but the Pentrwyn site's location is also very well hidden (it is only visible from the landward side from

approximately 15-20m from the North). It is much more visible from the sea; as is the natural harbour of Pigeon's Cave accessible just below the Pentrwyn site. This Cave was also the site of the discovery of the only Bronze Age hoard so far found on the Great Orme. This hoard included two incised, lock-rings, thought to be made of Irish gold. The fragment of shale bangle found at Pentrwyn during the original excavation in 1998 also hints at the Great Orme's position within wider trade networks.

Are we looking at outsiders coming in by sea, assessing ores near their anchorage before leaving with larger quantities of ore and smelting the ore elsewhere?

No evidence for large-scale smelting has yet been found on the Great Orme, perhaps none took place there. The availability of the large amounts of charcoal needed for large-scale smelting could well have been a major issue even with a locally organised coppicing regime. Perhaps only small-scale assaying took place on the Great Orme with larger-scale smelting taking place nearer to better sources of charcoal.

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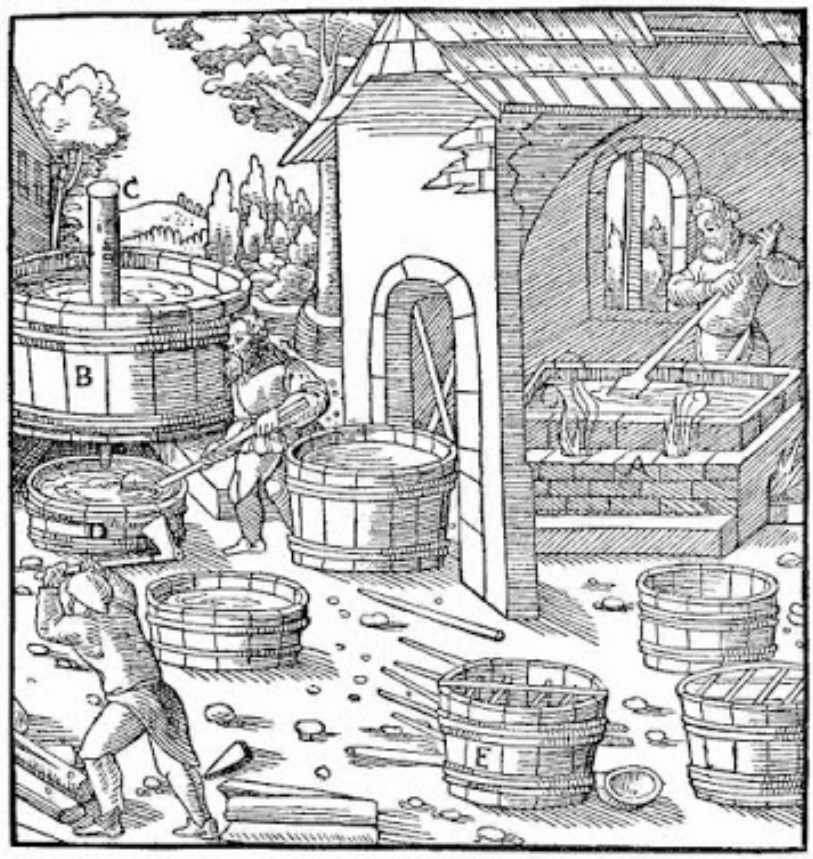
See also assaying in The Way of the Crucible. Robert Allen Bartlett

Saltpeter

Nitre, potassium nitrate KNO3, more commonly known as saltpetre, is formed in warm climates by bacterial action during the decomposition of excreta and vegetable refuse. Where people and animals live in close proximity, debris accumulates in and around their homes. The contact between putrefying material, alkaline soil, plant ashes, air and moisture allows 'nitrification' - that is the conversion of nitrogen compounds from animal and plant decay into nitrates which penetrate the soil. Dissolved in rainwater, the deposits evaporate on the surface to form crude saltpetre, as a white flower like powder. This must be washed to remove earth and impurities; then boiled and evaporated to refine it.



A—Caldron. B—Large vat into which sand is thrown. C—Plug. D—Tub. E—Vat containing the rods.

In the fifteenth and sixteenth centuries in Europe, saltpeter's purpose was well understood in the manufacture of gunpowder, but its sources were not. People were not too sure if it could be mined as a mineral or grown in a field like crops. As late as the 1770s, one noted chemistry lecturer admitted that 'we are much in the dark as to the origin and generation of saltpeter', although he knew that it was to be found around 'earth and stones that have been impregnated with animal or vegetable juices susceptible of putrefaction, and have long been exposed to the air... It is a product of elements, deposited in the bosom of the earth... and may not improperly be called the universal and unspecific mercury.' As saltpeter is found as an efflorescence on the surface of the earth, it was assumed by many chemists that it was of aerial origin. In 1821, John Davy, the brother of noted chemist, Sir Humphry Davy, after examining some niter-yielding caverns of Sri Lanka, concluded that it was formed from the nitrogen and oxygen in the air. Around 1890 is when the role of bacteria in the nitrification process was understood. In fact, the full process of nitrification was

not understood until the twentieth century.

In some parts of the world blessed with the optimum weather conditions and soil chemistry, saltpeter could be mined right off the ground. However, there are few places in the world with this correct mix of factors: parts of Northern India, Egypt, Spain and the Atacama desert in South America are some of the well known ones. Northern India, in particular, was well known for its saltpeter trade and this was exported to the middle east in the thirteenth and fourteenth centuries, and from then on, to Europe. However, others had discovered artificial methods of making saltpeter as well and these came to European notice as well. We will study the artificial methods of making saltpeter first.

The technology of making saltpeter by artificial means seems to have been invented in Asia and spread westwards into Europe. As might be expected, the Italian states, especially Venice, with their trading interests with the Turkish empire and the middle east, were the first Europeans to gain the knowledge from Asia, of how to produce saltpeter by artificial means. The metallurgist, Vannoccio Biringuccio, from Siena, wrote a well-known book on metalworking, De La Pirotechnia, which was published in 1540, shortly after his death. In this book, along with dealing with metals and alloys, there are notes devoted to saltpeter production. It is known that Biringuccio had a monopoly on saltpeter production in Siena around 1524, so he must have had knowledge of the process before then. This book was copied by several authors and eventually translated into English, and this is how the knowledge of the process gradually spread northwards in Europe.

In most of Europe, and England in particular, they were initially content to simply purchase the ingredients and finished gunpowder from other sources. In particular, trading with the Mediterranean countries for sulfur, saltpeter and gunpowder and northern European countries for saltpeter and gunpowder. Northern Europe was preferred as a source of gunpowder because the commodities were strategically located for military operation on the European continent.

England's need for gunpowder accelerated under King Henry VIII. When he invaded France in 1513, his army carried 510 tons of gunpowder with them, but the siege guns consumed 32 tons of powder a day. Very soon, he was importing gunpowder from other European countries. He commissioned a German named Hans Wolf to travel 'from shire to shire, to find a place where there is stuff to make saltpeter of.' His successor, Queen Elizabeth I, faced the Spanish Armada, and caused the demand for gunpowder to go even higher. She granted a Dutchman, one Gerard Honrick, the sum of 300 pounds, to teach her subjects the art of saltpeter making. His rules:

Black earth, the richer the better. The color shows the rich organic decomposition. Urine - especially from those that drank wine of strong beer Dung - especially from horses fed with oats Lime made from oyster shells or plaster of Paris

The moistened ingredients were to be layered in beds to which ashes were added (ashes from oak leaves being recommended) and the resulting salts were

to be leached out and boiled to form the crystals of saltpeter.

The following instructions come from a book called De re Metallica (it means, On the Nature of Metals in Latin), written by Georg Bauer, better known by his pen name of Georgius Agricola. It was published in 1556 and undoubtedly influenced by the above mentioned De la Pirotechnia. This was an influential book in the fields of chemistry and mining and remained an authoritative text on mining for 180 years after its publication. There is a chapter on saltpeter extraction, which we will describe below:

Saltpeter diggers would dig up soil found near stables or dovecotes, where there was a strong concentration of dung. The best saltpeter came from a dry, slightly fatty earth, which if retained for a while in the mouth, has an acrid or salty taste. Then, they would take a large vat, (B in the figure above), and fill it with layers of this soil and a powder in layers of a palm deep. The powder consists of two parts of unslaked lime and three parts of ashes of oak, holmoak, Italian oak or Turkish oak or some such suitable material. Alternate layers of soil and powder are filled in the large vat, to about three quarters of a foot from the top. Then water is added until the vat becomes full. As the water seeps into the material, it dissolves the saltpeter. Then the plug (C in the figure above) is pulled and the solution is drained into smaller tubs (D in the figure above). The solution is then poured into a caldron or reduction pan (A in the figure above), which is a flat shallow pan made of copper, which is placed on top of a fire. Here, the solution is boiled for several hours until about half of the water evaporates, and the solution is allowed to settle down. Any impurities in the solution form a dirty scum on top, which is then removed. Then it is boiled again and lye and rock alum are added to remove any further impurities and it is boiled again leaving behind a concentrated solution of saltpeter liquor. Then the concentrated solution is transferred to crystallization vats (E in the figure above). These vats have copper rods that act as nucleation sites for crystals of saltpeter to form on them. After three of four days, the rods are removed and the saltpeter crystals scraped off them. The solution left behind in the vats is partially used to wash the crystals after they are scraped off, and the rest of it is reboiled to concentrate the solution even more. The washed saltpeter crystals are placed on boards to drain and dry up.

Medieval Gunpowder Research Group

Report number 3 – August 2004

The Saltpetre Extraction Experiments

Middelaldercentret, Nykøbing, Denmark

Introduction

Evaluating the effectiveness and value of early cannon is not at all easy. Contemporary texts are not extensive nor are they easy to interpret and the problem is further exacerbated by the use of comparisons with which we are unfamiliar - what does 'very far' or 'much further' mean in the context of range or 'more powerful' or 'twice as strong' in that of the gunpowder itself. Just what were the ranges of early cannon and how fast was the shot going when it left the barrel are questions we are completely unable to answer with any accuracy. In an attempt to overcome these limitations, experimental work has been attempted to obtain some numerical data and as a means to more closely understand the sources. Over the past 5 years several successful replicas of early guns have been made and experiments with these have shown the effectiveness of these early weapons. However most of these trials have used modern gunpowder and, as useful as these experiments have been, they cannot be considered to have answered all the questions about just how effective these early gunpowder weapons really were. What is needed is a closer approximation to the gunpowder used in the past.

This problem was partly addressed by experiments in 2002 and 2003 when different gunpowder recipes were tried.[1] These showed that simple mixtures of gunpowder made quite effective propellants in a small piece of artillery in which the powder was tightly confined. However, although these experiments were carried out using gunpowder made with charcoal and sulphur produced as closely as possible to medieval methods, modern, pure saltpetre – potassium nitrate – was utilised. The question is how would this compare to medieval saltpetre and how would those differences affect the performance of the gunpowder and the artillery using it?

There are at least two factors that might affect the saltpetre. The first is what and how much impurities it might contain and the second is whether the saltpetre was potassium or calcium nitrate. Saltpetre was produced by extracting it from animal wastes in which it was formed by the action of bacteria. The extraction process was quite simple, washing the saltpetre and other salts out with water followed by precipitation from a saturated solution. However, though this process would concentrate the nitrates it could not completely separate them from other salts. Just what these would be, the amount present and their effect on the gunpowder made from it are all questions which we cannot answer.

The second important factor is its chemical composition. Extracting saltpetre from waste materials by a simple washing and precipitation method will result in calcium nitrate. To convert it to the potassium salt needs the addition of a potassium source, wood ashes, during the manufacturing process. Though this process is only directly referred to for the first time in the 16th century there is evidence from the 15th century that ashes were used in making saltpetre. This has led some writers to conclude that in the early phase of the use of gunpowder, calcium nitrate was used and that the numerous recipes for restoring decayed powder could be explained by the fact that it a particularly deliquescent salt which rapidly becomes damp when left in the open air. However experiments have shown that gunpowder made using just calcium saltpetre will not explode – in fact does not even ignite – so that the conversion process must have been known from the very beginnings of the use of gunpowder. However this has led to the proposition that saltpetre may have been very variable in quality - 'good' saltpetre makers converted almost all the calcium to the potassium salt (and kept the amount of other impurities to an absolute minimum) whereas others did not manage either the conversion process nor the purification process well enough and the resultant powder was liable to become damp over time and really was not a very good powder at all. However this must remain, for the moment, somewhat conjectural. In order for us to more fully understand early gunpowder,

what is required is some way to evaluate the saltpetre that may have been made in the period before 1500 and to this end experiments to extract it from a bed of animal waste were attempted as a first step.

The 'nitre bed'

The bed from which we hoped to extract nitrates was assembled in 2001. It consisted of a pit, approximately 1 metre deep by approximately 3 metres square, in which layers of chicken shit approximately 30 cms thick were alternated with thin layers, about 5 cms thick, of lime. Once full the top was covered with a layer of straw and a chicken house was built over the top of the pit in which chickens were kept. Periodically pig urine was added to the pit and it was aerated by forcing an iron bar repeatedly into it.

Figure 1. The nitre bed with the chicken house built over it

In August 2004 part of the contents of the pit were dug out and an attempt was made to extract nitrates from it. On digging down into the bed a strong ammonia-like smell was very noticeable. The upper layers appeared to consist of large clods of manure while further down there was a grey, crumbly 'earth'.

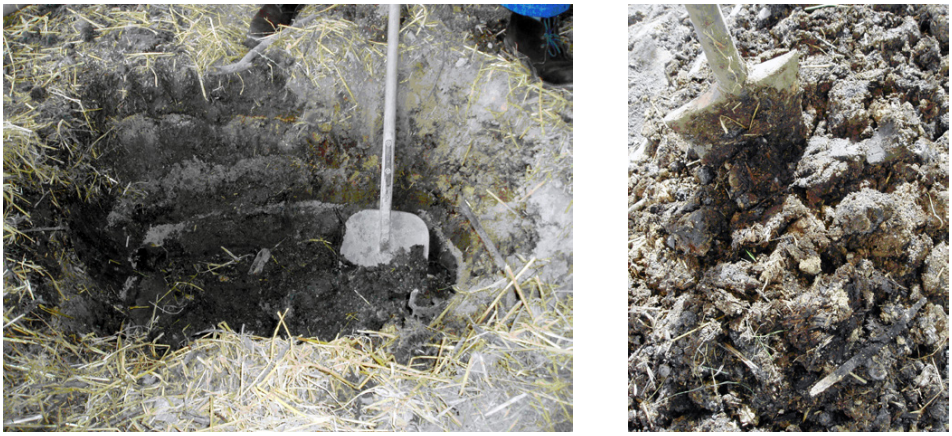


Figure 2. Left - digging out the nitre bed showing the layers of chicken shit and lime. Right – a close up of the material from the nitre bed

The extraction process

There are no detailed descriptions of the extraction of saltpetre from a 'nitre bed' before the 16th century. For our experiments the actual process used was a mixture of what was used then and some educated guesswork. In addition the process was conducted in the public area of the Medieval Centre in Nykobing in Denmark so that it was carried out, as far as possible, using medieval type utensils and equipment and wearing medieval dress!

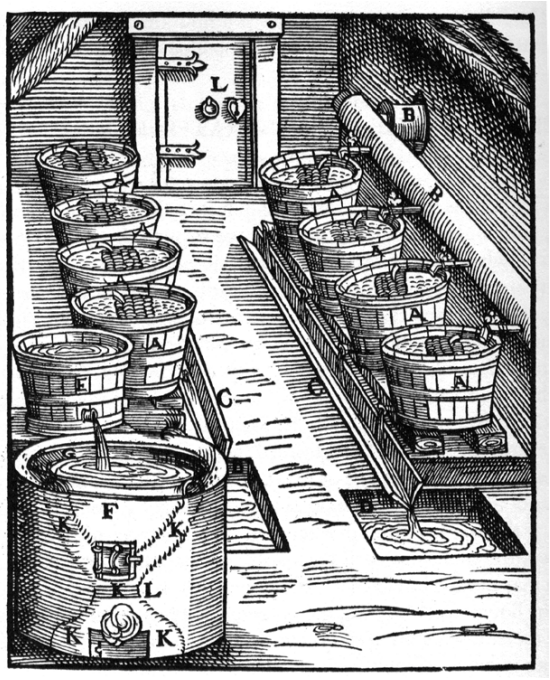


Figure 3. Saltpetre extraction – from Lazarus Ercker, Treatise on ores and assaying, 1580

Figure 4. The contents of a barrel containing the chicken manure draining into a second container

The process was carried out as follows. Wooden barrels were used in which a small hole, approximately 1 cm in diameter was made in the bottom and fitted with a wooden plug. These were then filled as follows: first a layer of twigs was laid down in the bottom of the barrel. These were then covered with a layer of straw about 7-8cms thick. A layer of ashes was then spread over the straw – approximately a kilogram of ashes from a wood fire. The container was then filled to within about 7cms of the top with the material from the nitre bed and finally water added to near the top of the container. This was then left for a period of between an hour and overnight – about 18 hours. The wooden plug was then removed and the water allowed to drain into a second container. Where the flow of liquid was very slow the contents of the container were agitated with a stick to speed up the process.

The liquid obtained, which ranged from a light to a quite dark brown, was then poured through a piece of fabric to remove any coarse solid material into an iron cauldron. After the first filling of water had drained through the container, it was refilled with fresh water which was also allowed to drain through and this was then used as the liquid to add to a second barrel which had been filled with fresh twigs, straw, ashes and chicken shit as before. In this way it was hoped to maximise the extraction of nitrate from the manure.

Figure 5. The complete set up for the extraction showing the two barrels and collecting containers

Figure 6. Boiling down the leachate and removing the scum that formed with a ladle

The same procedure was then repeated until ten loads of the chicken manure had been extracted in total. The leachates from all the extractions were then boiled down to about approximately 10 litres in total. As it boiled a thick scum continually rose to the surface and this was removed using an iron ladle. The whole process took approximately 5 days to complete.

Analysis

At each stage in the process samples of the leachates were taken and analysed for the concentration of nitrate that they contained.

Sample number	Extraction number	Concentration ppm	Notes
1	L01A	480	Single
2	L01B	-	Sample empty
3	L02A	550	Double
4	L02B	1300	Second water
5	L03A	1000	Double
6	L04A	1200	Single
7	L04B	700	Second water
8	L05A	700	Double
9	L05B	1200	Second water
10	L06A	1300	Double
11	L06B	420	Second water (After shaking 440 ppm)
12	L07A	5000	Double - Left overnight
13	L08A	1200	Single - Left overnight
14	L08B	460	Second water
15	L09A	1200	Double
16	L10A	1200	Double
17	L10B	1500	Second water
18	L11A	-	-
19	L11A	-	-
20	L12A	1900	-

Note: Single means that it was the result of a single pass through with fresh water, second water is the second extraction of a barrel and double means that the water used was partly the second water with some added fresh water.

Further filtration

The final boiled down leachate, approximately 5 litres in total, was a very dark brown liquid. To try to obtain a clear solution this was filtered through coffee filters several times but these did not remove the colour and the resultant liquid was still a dark brown and somewhat oily. As a trial a small amount, approximately 150 ml of this filtered material was then boiled down until crystals could be seen forming. On cooling, dark brown coloured crystals were found in the bottom of the container. The problem was how to produce clean white nitrate crystals. Pouring off the resultant brown slightly viscous brown liquid and re-dissolving the precipitate in clean water and boiling that down did not really produce much of a change though the crystals changed from dark to a lighter shade of brown.

A review of the literature on saltpetre brought out the following 17th century text:

> But the workmen seldom make use of any further indication, than by finding the liquor hang like oyl on the sides of the brazen-scummer, when 'tis dipped into it, which is a sign it is fit to be passed through the ashes, which is done in this manner.
>
> You must prepare two tubs fitted after the manner of the first, where you put the

> earth, saving that at the bottom of these tubs, you must lay reeds or straw about a foot high, over them place loose boards, pretty near one another, over them, a little more straw (which is to keep the ashes from the top, and to give the liquor room to drain the better from them:) Then fill up your tubs with any sort of wood-ashes to half a foot of the top; then pour on the foresaid liquor, as it comes scalding hot out of the copper, and the ashes contained in the first tub; then after a while draw it off at the to; and so continue putting on and drawing off, first at one tub of ashes, then at the other, till your liquor grow clear, and lose the thick turbid colour it had when it went on.[2]

The implication is that the boiled down liquor in the 17th century, was also somewhat 'turbid' similar perhaps to what we had produced and that they used ashes and straw to filter it and of course to transform the calcium salt to potassium nitrate. To see whether we could produce a clearer solution a similar setup was attempted. Straw and ashes were put into a small plastic bucket as described above and the hot liquor poured through it. The resultant liquid was not really any different in appearance and was still very dark brown.

In order to ascertain just what we had made about one litre of the solution was boiled down till crystals could be seen forming and left to cool. Once cold and a precipitate formed excess liquid was poured off and the brown crystals re-dissolved in clean water and the process repeated before leaving the resultant precipitate to dry. This was then sent for analysis.

Results

Analysis of the precipitate proved it to be potassium sulphate with very little nitrate present. Intriguingly it shows that the conversion process – substituting potassium for calcium – worked very well. However the conversion of the waste material to nitrate had just not occurred. The reasons for this probably include:

- Insufficient aeration of the bed. The subsequent lack of oxygen slowing down and preventing the breakdown of the ammonium ions by bacteria to nitrates. This was exacerbated by the fact that the bed was sunk into a pit and not built up as a pile on the ground
- Insufficient addition of urine. Although urine was added it is clear, especially from the work of Williams (1975) that it is very necessary for higher yields.
- The use of bird faeces may have been detrimental as they tend to be highly acidic and there is some evidence that the bacteria involved in the breaking down processes are not tolerant of acidic conditions. The addition of lime to the original bed helped in this respect but it may be that insufficient was added.

The way forward

The experience gained from carrying out the extraction and precipitation has been invaluable in understanding the processes involved. The way forward is to build a nitre bed upon the ground made up of waste material from cows, pigs or horses and not from chickens. Urine must be added at regular intervals and the pile turned periodically to aerate it. Checking on the nitrate content of the bed should also be carried out at regular intervals – carrying out small-scale extractions coupled with analysis – to ensure that the bed is producing nitrate.

Robert D Smith
June 2005

Figure 7 The Group members who carried out the extraction of saltpetre

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Acknowledgements

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Notes

1 The reports of these trials can be found at www.middelaldercentret.dk/gunpowder2002.pdf and www.middelaldercentret.dk/gunpowder2003.pdf.
2 Taken from the 'History of the making of salt-peter' by Mr Henshaw in Sprat 1667.

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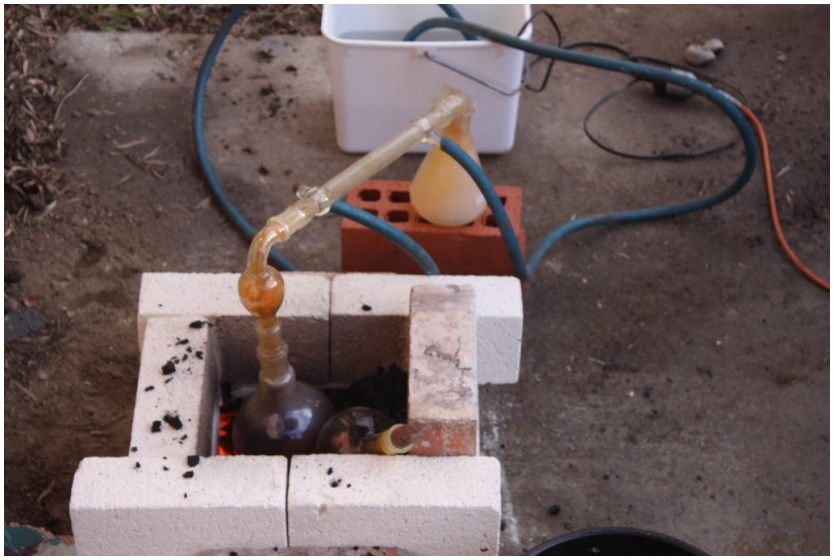
Hunting the Green Lyon - sublimation and distillations



Aqua regia made from sal ammoniac and salpeter distilled (also with some vitriol), or with aqua fortis and sal ammoniac, aqua fortis with common salt added.

Newton's Philosophy of Nature?

Twelve Keys of Basil Valentine

The 'Twelve Keys' appears to have first been published in 'Ein kurtz summarischer Tractat, von dem grossen Stein der Uralten...', Eisleben, 1599, and a number of editions were issued during the 17th and 18th centuries, in Latin, French, English and German. This important text was also included in a number of compendia, such as the *Musaeum Hermeticum*. The identity of Basil Valentine is unknown and it appears that the writings attributed to him were the product of the last decade of the 16th Century.

The Preface of Basilius Valentinus, the Benedictine

Concerning The Great Stone of the Ancient Sages.

When I had emptied to the dregs the cup of human suffering, I was led to consider the wretchedness of this world, and the fearful consequences of our first parents' disobedience. Then I saw that there was no hope of repentance for mankind, that they were getting worse day by day, and that for their impenitence God's everlasting punishment was hanging over them; and I made haste to withdraw myself from the evil world, to bid farewell to it, and to devote myself to the service of God.

When I had spent some years at the monastery, I found that after I had performed my work and my daily devotions I still had some time on my hands. This I did not wish to pass in idleness, lest my evil thoughts should lead me into new sins; and so I determined to use it for the study and investigation of those natural secrets by which God has shadowed out eternal things. So I read a great many books in our monastery written in olden times by philosophers who had pursued the same study, and was thereby stimulated to a more ardent desire of knowing that which they also knew. Though I did not make much progress at first, yet at last God granted my earnest prayer, and opened my eyes that I might see what others had seen before me.

In the convent there was a brother, who was afflicted with a severe disease of the kidneys, and to whom none of the many physicians he had consulted had been able to give even momentary relief. So he had committed himself to the hand of God, and despaired of all human aid.

As I loved him, I gathered all manner of herbs, extracted their salts, and distilled various medicines. But none of them

Alchemical texts

16th Century
Practical alchemy
Philosophical alchemy

17th Century
Practical alchemy
Philosophical alchemy

18th Century
Practical alchemy
Philosophical alchemy

Alchemical poetry

Alchemical allegories

Works of Nicolas Flamel
Works of George Ripley
Works of Sendivogius
Theatrum Chemicum Britannicum
Emerald tablet of Hermes
Rosicrucian texts
Literary works
Texts from Musaeum Hermeticum

Spanish alchemical texts
German alchemical texts
French alchemical texts
Russian alchemical texts
Italian alchemical texts

seemed to do him the slightest good, and after six years I found that I had tried every possible vegetable substance, without any beneficial effect.

At last I determined to devote myself to the study of the powers and virtues which God has laid into metals and minerals and the more I searched the more I found. One discovery led to another, and, after God had permitted unto me many experiments, I understood clearly the nature and properties, and the secret potency, imparted by God to minerals and metals.

Among the mineral substances I found one which exhibited many colours, and proved to be of the greatest efficacy in art. The spiritual essence of this substance I extracted, and therewith restored our sick brother, in a few days, to perfect health. For the strength of this spirit was so great as to quicken the prostrate spirit of my diseased brother, who, from that day to the day of his death, remembered me in his hourly prayers. And his prayers, together with my own diligence, so prevailed with God, that there was revealed to me that great secret which God ever conceals from those who are wise in their own conceits.

Thus have I been wishing to reveal to you in this treatise, as far as may be lawful to me, the Stone of the Ancients, that you, too, might possess the knowledge of this highest of earthly treasures for your health and comfort in this valley of sorrow. I write about it, not for my own good, but for that of posterity, and though my words be few and simple, that which they import is of immeasurable magnitude. Ponder them well, that you also may find the Rock which is the foundation Stone of truth, the temporal blessing, and the eternal reward.

The Tract of Basilius Valentinus, the Benedictine, Concerning the Great Stone of the Ancient Sages.

In the preface, gentle Reader, and zealous Student of this Art, I promised to communicate to you a knowledge of our Corner Stone, or Rock, of the process by which it is prepared, and of the substance from which it was already derived by those ancient Sages, to whom the secret of our Art was first revealed by God for the health and happiness of earthly life.

Let me assure you that I fully intend to fulfil my promise, and to be as plain with you as the rules of our Art permit, not misleading you by sophistical deceptions, but opening up to you the spring of all blessings even unto the fountain head. I propose to set forth what I have to say in a few simple, straightforward words, for I am no adept in the art of multiplying words; nor do I think that exuberance of language tends to clearness; on the contrary, I am convinced that it is many words that darken council. Let me tell you, then, that although many are engaged in the search after this Stone, it is nevertheless found but by very few. For God never intended that it should become generally known. It is rather to be regarded as a gift which He reserves for those favoured few, who love the truth, and hate falsehood, who study our Art earnestly by day and by night, and whose hearts are set upon God with an unfeigned affection.

Hence, if you would prepare our great and ancient Stone, I testify unto you in all truth that you must give diligent heed to my teaching, and before all things implore the gracious

blessing of the Creator of all things. You must also truly repent you of all your sins, confessing the same, and firmly resolve to lead a good and holy life. It is also necessary that you should determine to shew your gratitude to God for His unspeakable Gift, by succouring the poor and the distressed, and by opening your hand and your heart to the needy. Then God will bless your labour, and reward your search with success, and yourself with a seat in Heaven as the fruit of your faith.

Do not despise the truthful writings of those who possessed the Stone before us. For, after the enlightening grace of God, it is from them that I received my knowledge. Let your study of them be increased and repeated often, lest you lose the thread of insight, and the lamp of understanding be extinguished.

Give yourself wholly to study, and be not flighty or doubleminded. Let your mind be like a firm Rock, in which all the various sayings of the Sages are reduced to the unity of their common meaning. For a man who is easily influenced in different directions is not likely to find the right path.

As our most ancient Stone is not derived from combustible things, you should cease to seek it in substances which cannot stand the test of fire. For this reason it is absurd to suppose that we can make any use of vegetable substances, though the Stone, too, is endowed 'with a principle of growth.

If our Stone were a vegetable substance, it would, like other vegetables, be consumed by fire, leaving only a certain salt. Ancient writers have, indeed, described our Stone as the vegetable Stone. But that name was suggested to them by the fact that it grows and increases in size, like a plant.

Know also that animals only multiply after their kind, and within their own species. Hence our Stone can only be prepared out of its own seed, from which it was taken in the beginning; and hence also you will perceive that the soul of an animal must not be the subject of this investigation. Animals are a class by themselves; nor can anything ever be obtained from them that is not animal in its nature. But our Stone, as it has been bequeathed to me by the Ancients, is derived from two things, and one thing, in which is concealed a third thing. This is the purest truth, and a most faithful saying. For male and female have from of old been regarded as one body, not from any external or visible consideration, but on account of the ardour of that mutual love which naturally draws them together into one; and as the male and female seed jointly represent the principle of propagation, so also the sperm of the matter out of which our Stone is made can be sown and increased. There are in our substance two supplementary kinds of seed, from which our Stone may be prepared and multiplied.

If you are a true lover of our Art, you will carefully weigh and ponder these words, lest, with other sophisticators, you fall into the dangerous pit prepared by the common enemy of man. But whence are you to obtain this seed? This question you may most easily answer by asking yourself another question. What do you want to develop from this seed, and what use do you wish to make of it? There can be no doubt, then that it must be the root, or first substance, of metals, from which all metals derive their origin. It is, therefore, necessary that we should now proceed to speak of the generation of the metals.

In the beginning, when the Spirit of God moved upon the face

of the waters, and as yet all was involved in darkness, Almighty and Eternal God, Whose beginning and wisdom are from everlasting, by His inscrutable counsel created heaven and earth, and all that in them is, both visible and invisible, out of nothing. How the act of creation was accomplished I will not attempt to explain. This is a matter which is set forth to us in Holy Scripture, and must be apprehended by faith.

To each creature God gave its own seed, wherewith to propagate its kind, that in this way there might always be an increase of men and animals, plants and metals. Man was not to be able to produce new seed: he was only permitted to educe new forms of life out of that which already existed. The creating of seed God reserved to Himself For if man could create seed he would be equal to the Creator.

Know that our seed is produced in the following way. A celestial influence descends from above, by the decree and ordinance of God, and mingles with the astral proper ties. When this union has taken place, the two bring forth a third namely, an earth-like substance, which is the principle of our seed, of its first source, so that it can shew an ancestry, and from which three the elements, such as water, air, and earth, take their origin. These elements work underground in the form of fire, and there produce what Hermes, and all who have preceded me, call the three first principles, viz., the internal soul, the impalpable spirit, and visible bodies, beyond which we can find no earlier beginning of our Magistery.

In the course of time these three unite, and are changed through the action of fire into a palpable substance, viz., quicksilver, sulphur, and salt. If these three substances be mixed, they are hardened and coagulated into a perfect body, which represents the seed chosen and appointed by the Creator. This is a most important and certain truth. If the metallic soul, the metallic spirit, and the metallic form of body be present, there will also be metallic quicksilver, metallic sulphur, and metallic salt, which together make up the perfect metallic body.

If you cannot perceive what you ought to understand herein, you should not devote yourself to the study of philosophy.

Moreover, I tell you in few words, that you cannot obtain a metallic body except by perfectly joining these three principles into one. Know, also, that all animals are, like man, composed of flesh and blood, and also possess a vitalizing spirit, but are destitute of the rational soul which the Creator gave to man alone. Therefore, when animals die, they perish for ever. But when man yields up his mortal life into the hands of his Creator, his soul does not die. It returns, and is united to the glorified body, in which, after the Resurrection, soul and spirit dwell together once more in eternal glory, never to be separated again throughout all eternity.

Hence the rational soul of man makes him an abiding creature, and, though his body may seem to die, yet we know that he will live for ever. For to him death is only a process of purification, by means of which he is freed from his sins, and translated to another and better place. But there is no resurrection for the brute beasts, because they have no rational soul, for which alone our Lord and Saviour shed His blood.

For though a body may be vitalized by a spirit, yet it need not, therefore, be fixed, unless, indeed, it possess a rational soul, that strong bond between body and spirit, which represents their union, and resists all efforts to separate them. Where

there is no soul, there is no hope of redemption. Nothing can be perfect or lasting without a soul. This is a profound and most important truth, which I feel in conscience bound to make known to my readers. Now, the spirits of metals have this property of fixedness in a greater or less degree; they are more or less volatile in proportion to the mutual fitness of their bodies and souls. A metal that has the three conditions of fixedness is not affected by fire or overcome by any other outward agent. But there is only one metal that fulfils these conditions, namely, gold. Silver also contains fixed mercury, and is not so quickly volatilised as the imperfect metals, but stands the trial of fire, and yields no food to voracious Saturn.

Amatory Venus is clothed with abundant colour, and her whole body is one pure tincture, not unlike the red colour which is found in the most precious of metals. But though her spirit is of good quality, her body is leprous, and affords no permanent substratum to the fixed tincture. Hence the soul has to share the fate of the imperfect body, and when the body dies the soul has to leave it. For its dwelling has been destroyed by fire, and it is without a house wherein to abide.

Fixed salt has imparted to warlike Mars a hard, firm, and durable body, which is evidence of the generosity of his soul; nor can fire be said to have much power over it. And if its strength be united to the beauty of Venus, I do not say but that a precious and harmonious result may be obtained. For the phlegmatic or humid quality of the Moon may be heated with the ardent blood of Venus, and the blackness of Venus removed with the strong salt of Mars.

You need not look for our metallic seed among the elements. It need not be sought so far back. If you can only rectify the Mercury, Sulphur, and Salt (understand, those of the Sages) until the metallic spirit and body are inseparably joined together by means of the metallic soul, you thereby firmly rivet the chain of love, and prepare the palace for the coronation.

These things represent a liquid key, comparable to the celestial influence, and a dry water joined to the terrestrial substance: all which are one thing, derived from three, and two, and one. If you understand this, you have already attained our Magistery. Then you must join the husband and wife together that each may feed upon the other's flesh and blood, and that so they may propagate their species a thousandfold.

Though I would fain reveal this matter to you more plainly and openly, I am prohibited from doing so by the law of God, and by the fear of His wrath, and of eternal lest the gift of the Most High should be abused.

If, however, you do not understand the theoretical part of my work, perhaps the practical part will serve to enlighten you more fully. I will therefore proceed to shew how, by the help of God, I was enabled to prepare the Stone of the Ancients, and, for your further instruction, I will add twelve keys, in which I give a figurative account of our Art.

Take a quantity of the best and finest gold, and separate it into its component parts by those media which Nature vouchsafes to those who are lovers of Art, as an anatomist dissects the human body. Thus change your gold back into what it was before it became gold; and thou shalt find the seed, the beginning, the middle, and the end-that from which our gold and its female principle are derived, viz., the pure and subtle spirit, the spotless soul, and the astral salt and

balsam. When these three are united, we may call them the mercurial liquid: a water which was examined by Mercury, found by him to be pure and spotless, and therefore espoused by him as his wife. Of the two was born an incombustible oil; for Mercury became so proud that he hardly knew himself. He put forth eagle feathers, and devoured the slippery tail, of the Dragon, and challenged Mars to battle.

Then Mars summoned his horsemen, and bade them enclose Mercury in prison under the ward of Vulcan, until he should be liberated by one of the female sex. When this became known, the other Planets assembled and held a deliberation on the question, what would be the best and wisest course to adopt. When they were met together, Saturn first came forward, and delivered himself as follows:

" I, Saturn, the greatest of the planets in the firmament, declare here before you all, that I am the meanest and most unprofitable of all that are here present, that my body is weak, corruptible, and of a swarthy hue, but that, nevertheless, it is I that try you all. For having nothing that is fixed about me, I carry away with me all that is of a kindred nature. My wretchedness is entirely caused by that fickle and inconstant Mercury, by his careless and neglectful conduct. Therefore, I pray you, let us be avenged on him, shut him up in prison, and keep him there till he dies and is decomposed, nay, until not a drop of his blood is to be seen."

Then yellow Jupiter stepped forward, bent his knees, inclined his sceptre, and with great authority bade them carry out the demand of Saturn. He added that he would punish everyone who did not aid the execution of this sentence.

Then Mars presented himself, with sword drawn -- a sword that shone with many colours, and gave out a beautiful and unwonted splendour. This sword he gave to the warder Vulcan, and bade him slay Mercury, and burn him, together with his bones, to ashes. This Vulcan consented to do.

While he was executing his office, there appeared a beautiful lady in a long, silver robe, intertissued with many waters, who was immediately recognised as the Moon, the wife of the Sun. She fell on her knees, and with outspread hands, and flowing tears, besought them to liberate her husband -- the Sun -- from the prison in which, through the crafty wiles of Mercury, he was being detained by the Planets. But Vulcan refused to listen to her request; nor was he softened by the moving prayers of Lady Venus, who appeared in a crimson robe, intertissued with threads of green, and charmed all by the beauty of her countenance and the fragrance of the flowers which she bore in her hand. She interceded with Vulcan, the Judge, in the Chaldee tongue, and reminded him that a woman was to effect the deliverance of the prisoner. But even to her pleading he turned a deaf ear.

While they were still speaking the heaven was opened, and there came forth a mighty animal, with many thousands of young ones, which drove the warder before it, and opening its mouth wide, swallowed Venus, its fair helper, at the same time exclaiming with a loud voice: " I am born of woman, woman has propagated my seed, and therewith filled the earth Her soul is devoted to mine, and therefore I must be nourished with her blood." When the animal had said these words with a loud voice, it hastened into a certain chamber, and shut the door behind it; whither its voracious brood followed, drinking of the aforesaid incombustible oil, which they digested with the greatest ease, and thereby became even more numerous than they had been before. This they

continued to do until they filled the whole world.

Then the learned men of that country were gathered together, and strove to discover the true interpretation of all they had seen. But they were unable to agree until there came forward a man of venerable age, with snowy locks and silvery beard, and arrayed in a flowing purple robe On his head he wore a crown set with brilliant carbuncles. His loins were girded with the girdle of life. His feet were bare, and his words penetrated to the depth of the human soul. He mounted the tribune, and bade the assembly listen to him in silence, since he was sent from above to explain to them the significance of what they had seen.

When perfect silence prevailed, he delivered himself as follows:

"Awake, O man, and behold the light, lest the darkness deceive thee! The Gods revealed to me this matter in a profound sleep. Happy is the man who knows the great works of the Divine power. Blessed is he whose eyes are opened to behold light where before they saw darkness.

"Two Stars are given by the Gods to man to lead him to great wisdom. Gaze steadily upon them, follow their lights, and you will find in them the secret of knowledge.

"The bird Phoenix, from the south, plucks out the heart of the mighty beast from the east. Give the animal from the east wings, that it may be on an equality with the bird from the south. For the animal from the east must be deprived of its lion's skin, and lose its wings. Then it must plunge in the salt water of the vast ocean, and emerge thence in renovated beauty. Plunge thy volatile spirits in a deep spring whose waters never fail, that they may become like their mother, who is hidden therein, and born of three.

"Hungary is my native land, the sky and the stars are my habitation, the earth is my spouse. Though I must die and be buried, yet Vulcan causes me to be born anew. Therefore, Hungary is my native land, and my mother encloses the whole world."

When all that were present had received these his sayings, he thus continued:

"Cause that which is above to be below; that which is visible, to be invisible; and that which is palpable, to become impalpable. Again, let that which is below become that which is above; let the invisible become visible, and the impalpable, palpable. Here you see the perfection of our Art, without any defect, or diminution. But that in which death and life, destruction and resurrection dwell, is a round sphere, with which the goddess of fortune drives her chariot, and imparts the gift of wisdom to men of God. Its proper name here upon earth, and for the human understanding, is 'All-in-All.'

"Let him who would know what this 'All-in-All' is, give the earth great wings, and make it fly upward through the air to the heavenly regions. Then singe its wings with fierce heat, and make it fall into the Red Sea, and there be drowned. Then dry up the water with fire and air till the earth reappears, and you will have 'All-in-All.'

"If you cannot find it in this way, look around upon the things that are in the world. Then you will find the ' All-in-All,' which is the attracting force of all metals and minerals derived from salt and sulphur, and twice born of Mercury. More I may not say about ' All-in-All,' since all is comprehended in all.

"My friends, blessed are ye if, by listening to the words of the wise, ye can find this great Stone, which has power to cure leprous and imperfect metallic bodies and to regenerate them; to preserve men in health, and procure for them a long life -- as it has hitherto kept the vital fire burning within me so long that I am weary of life, and yearn to die.

"For His wisdom and mercy, and for the gracious Gift which He has bestowed upon me so long ago, I am bound to render God thanks, now and evermore. Amen."

When the old man had thus spoken, he vanished from their sight.

But all who had heard him went each man to his house, and meditated on his words by day and by night.

Here follow the Twelve Keys of Basilius Valentinus, the Benedictine, with which we may open the doors of the knowledge of the Most Ancient Stone and unseal the Most Secret Fountain of Health.

FIRST KEY

Let my friend know that no impure or spotted things are useful for our purpose. For there is nothing in their leprous nature capable of advancing the interests of our Art There is much more likelihood of that which is in itself good being spoiled by that which is impure. Everything that is obtained from the mines has its value, unless, indeed, it is adulterated. Adulteration, however, spoils its goodness and its efficacy.

As the physician purges and cleanses the inward parts of the body, and removes all unhealthy matter by means of his medicines, so our metallic substances must be purified and refined of all foreign matter, in order to ensure the success of our task. Therefore, our Masters require a pure, immaculate body, that is untainted with any foreign admixture, which admixture is the leprosy of our metals.

Let the diadem of the King be of pure gold, and let the Queen that is united to him in wedlock be chaste and immaculate.

If you would operate by means of our bodies, take a fierce grey wolf, which, though on account of its name it be subject to the sway of warlike Mars, is by birth the offspring of ancient Saturn, and is found in the valleys and mountains of the world, where he roams about savage with hunger. Cast to him the body of the King, and when he has devoured it, burn him entirely to ashes in a great fire. By this process the King will be liberated; and when it has been performed thrice the Lion has overcome the wolf, and will find nothing more to devour in him. Thus our Body has been rendered fit for the first stage of our work.

Know that this is the only right and legitimate way of purifying our substance: for the Lion purifies himself with the blood of the wolf, and the tincture of its blood agrees most wonderfully with the tincture of the Lion, seeing that the two liquids are closely akin to each other. When the Lion's hunger is appeased, his spirit becomes more powerful than before, and his eyes glitter like the Sun. His internal essence is now of inestimable value for the removing of all defects, and the healing of all diseases. He is pursued by the ten lepers, who desire to drink his blood; and all that are tormented with any kind of sickness are refreshed with this blood.

For whoever drinks of this golden fountain, experiences a renovation of his whole nature, a vanishing of all unhealthy matter, a fresh supply of blood, a strengthening of the heart and of all the vitals, and a permanent bracing of every limb. For it opens all the pores, and through them bears away all that prevents the perfect health of the body, but allows all that is beneficial to remain therein unmolested.

But let my friend be scrupulously careful to preserve the fountain of life limpid and clear. If any strange water be mixed with it, it is spoiled, and becomes positively injurious. If it still retain any of the solvent which has been used for its dissolution, you must carefully purge it off. For no corrosive can be of the least use for the prevention of internal diseases.

When a tree is found to bear sour and unwholesome fruit, its branches must be cut off, and scions of better trees grafted upon it. The new branches thereupon become organically united to the trunk; but though nourished with its sap, they thence forward produce good and pleasant fruit.

The King travels through six regions in the heavenly firmament, and in the seventh he fixes his abode. There the royal palace is adorned with golden tapestry. If you understand my meaning, this Key will open the first lock, and push back the first bolt; but if you do not, no spectacles or natural eyesight will enable you to understand what follows. But Lucius Papirius has instructed me not to say any more about this Key.

SECOND KEY

In the houses of the great are found various kinds of drink, of which scarcely two are exactly like each other in odour, colour, or taste. For they are prepared in a great variety of different ways. Nevertheless they are all drunk, and each is designed for its own special use. When the Sun gives out his rays, and sheds them abroad upon the clouds, it is commonly said that he is attracting water, and if he do it frequently, and thereby cause rain, it is called a fruitful year.

If it be intended to build a palace, the services of many different craftsmen must be employed, and a great variety of materials is required. Otherwise the palace would not be worthy the name. It is useless to use wood where stone is necessary.

The daily ebb and flow of the sea, which are caused by the sympathetic influence of heavenly bodies, impart great wealth and blessing to the earth. For whenever the water comes rolling back, it brings a blessing with it.

A bride, when she is to be brought forth to be married, is gloriously adorned in a great variety of precious garments, which, by enhancing her beauty, render her pleasant in the eyes of the bridegroom. But the rites of the bridal night she performs without any clothing but that which she was arrayed withal at the moment of her birth.

In the same way our bridal pair, Apollo and Diana, are arrayed in splendid attire, and their heads and bodies are washed with various kinds of water, some strong, some weak, but not one of them exactly like another, and each designed for its own special purpose. Know that when the moisture of the earth ascends in the form of a vapour, it is condensed in the upper regions, and precipitated to the earth by its own weight. Thus the earth regains the moisture of which it had been deprived, and receives strength to put forth buds and herbs. In the same way you must repeatedly distil the water which you have extracted from the earth, and then again restore it to your earth, as the water in the Strait of Euripus frequently leaves the shore, and then covers it again until it arrives at a certain limit.

When thus the palace has been constructed by the hands of many craftsmen, and the sea of glass has absolved its course, and filled the palace with good things, it is ready for the King to enter, and take his seat upon the throne. But you should notice that the King and his spouse must be quite naked when they are joined together. They must be stripped of all their glorious apparel, and must lie down together in the same

state of nakedness in which they were born, that their seed may not be spoiled by being mixed with any foreign matter.

Let me tell you, in conclusion, that the bath in which the bridegroom is placed, must consist of two hostile kinds of matter, that purge and rectify each other by means of a continued struggle. For it is not good for the Eagle to build her nest on the summit of the Alps, because her young ones are thus in great danger of being frozen to death by the intense cold that prevails there.

But if you add to the Eagle the icy Dragon that has long had its habitation upon the rocks, and has crawled forth from the caverns of the earth, and place both over the fire, it will elicit from the icy Dragon a fiery spirit, which, by means of its great heat, will consume the wings of the Eagle, and prepare a perspiring bath of so extraordinary a degree of heat that the snow will melt upon the summit of the mountains, and become a water, with which the invigorating mineral bath may be prepared, and fortune, health, life, and strength restored to the King.

THIRD KEY

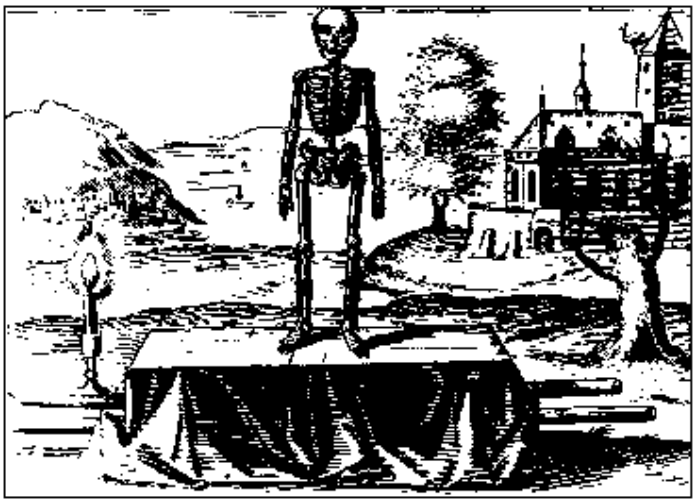
By means of water fire may be extinguished, and utterly quenched. If much water be poured upon a little fire, the fire is overcome, and compelled to yield up the victory to the water. In the same way our fiery sulphur must be overcome by means of our prepared water. But, after the water has vanished, the fiery life of our sulphurous vapour must triumph, and again obtain the victory. But no such triumph can take place unless the King imparts great strength and potency to his water and tinges it with his own colour, that thereby he may be consumed and become invisible, and then again recover his visible form, with a diminution of his simple essence, and a development of his perfection.

A painter can set yellow upon white, and red or crimson upon yellow; for, though all these colours are present, yet the latter prevails on account of its greater intensity. When you have accomplished the same thing in our Art, you have before your eyes the light of wisdom, which shines in the darkness, although it does not burn. For our sulphur does not burn, but nevertheless its brilliancy is seen far and near. Nor does it colour anything until it has been prepared, and dyed with its own colour, which it then imparts to all weak and imperfect metals. This sulphur, however, cannot impart this colour until it have first by persevering labour been prevailed upon to

abjure its original colour. For the weaker does not overcome the stronger, but has to yield the victory to it. The gist of the whole matter lies in the fact that the small and weak cannot aid that which is itself small and weak, and a combustible substance cannot shield another substance from combustion. That which is to protect another substance against combustion must itself be safe from danger. The latter must be stronger than the former, that is to say, it must itself be essentially incombustible. He, then, who would prepare the incombustible sulphur of the Sages, must look for our sulphur in a substance in which it is incombustible -- which can only be after its body has been absorbed by the salt sea, and again rejected by it. Then it must be so exalted as to shine more brightly than all the stars of heaven, and in its essence it must have an abundance of blood, like the Pelican, which wounds its own breast, and, without any diminution of its strength, nourishes and rears up many young ones with its blood. This Tincture is the Rose of our Masters, of purple hue, called also the red blood of the Dragon, or the purple cloak many times folded with which the Queen of Salvation is covered, and by which all metals are regenerated in colour.

Carefully preserve this splendid mantle, together with the astral salt which is joined to this sulphur, and screens it from harm. Add to it a sufficient quantity of the volatility of the bird; then the Cock will swallow the Fox, and, having been drowned in the water, and quickened by the fire, will in its turn be swallowed by the Fox.

FOURTH KEY



All flesh that is derived from the earth, must be decomposed and again reduced to earth; then the earthy salt produces a new generation by celestial resuscitation. For where there was not first earth, there can be no resurrection in our Magistery. For in earth is the balm of Nature, and the salt of the Sages.

At the end of the world, the world shall be judged by fire, and all those things that God has made of nothing shall by fire be reduced to ashes, from which ashes the Phoenix is to produce her young. For in the ashes slumbers a true and genuine tartaric substance, which, being dissolved, will enable us to open the strongest bolt of the royal chamber.

After the conflagration, there shall be formed a new heaven and a new earth, and the new man will be more noble in his glorified state than he was before.

When the sand and ashes have been well matured and ripened with fire, the glass-blower makes out of it glass, which remains hard and firm in the fire, and in colour resembles a crystal stone. To the uninitiated this is a great mystery, but not to the master whom long experience has familiarized with the process.

Out of stones the master also prepares lime by burning which is very useful for our work- But before they are prepared with fire, they are mere stones. The stone must be matured and rendered fervent with fire, and then it becomes so potent that few things are to be compared to the fiery spirit of lime.

By burning anything to ashes you may gain its salt. If in this dissolution the sulphur and mercury be kept apart, and restored to its salt, you may once more obtain that form which was destroyed by the process of combustion. This assertion the wise of this world denounce as the greatest folly, and count as a rebellion, saying that such a transformation would amount to a new creation, and that God has denied such creative power to sinful man. But the folly is all on their side. For they do not understand that our Artist does not claim to create anything, but only to evolve new things from the seed made ready to his hand by the Creator.

If you do not possess the ashes, you will be unable to obtain our salt; and without our salt you will not be able to impart to our substance a bodily form; for the coagulation of all things is produced by salt alone.

As salt is the great preserving principle that protects all things from decay, so the Salt of our Magistery preserves metal from decomposition and utter annihilation. If their Balm were to perish, and the Spirit to leave the body, the body would be quite dead, and no longer available for any good purpose. The metallic spirit would have departed, and would have left its habitation empty, bare, and lifeless.

Observe also, thou who art a lover of this Art, that the salt that is gained from ashes has great potency, and possesses many concealed virtues. Nevertheless, the salt is unprofitable, until its inward substance has been extracted. For the spirit alone gives strength and life. The body by itself profits nothing. If you know how to find this spirit, you have the Salt of the Sages, and the incombustible oil, concerning which many things have been written before my time.

Although many philosophers
Have sought for me with eagerness,
Yet very few succeed at length
In finding out my secret virtue.

FIFTH KEY

The quickening power of the earth produces all things that grow forth from it, and he who says that the earth has no life makes a statement which is flatly contradicted by the most ordinary facts. For what is dead cannot produce life and growth, seeing that it is devoid of the quickening spirit. This spirit is the life and soul that dwell in the earth, and are nourished by heavenly and sidereal influences. For all herbs, trees, and roots, and all metals and minerals, receive their growth and nutriment from the spirit of the earth, which is the spirit of life. This spirit is itself fed by the stars, and is thereby rendered capable of imparting nutriment to all things that grow, and of nursing them as a mother does her child while it is yet in the womb. The minerals are hidden in the womb of the earth, and nourished by her with the spirit which she receives from above.

Thus the power of growth that I speak of is imparted not by the earth, but by the life-giving spirit that is in it. If the earth were deserted by this spirit, it would be dead, and no longer able to afford nourishment to anything. For its sulphur or richness would lack the quickening spirit without which there can be neither life nor growth.

Two contrary spirits can scarcely dwell together, nor do they easily combine. For when a thunderbolt blazes amidst a tempest of rain, the two spirits, out of which it is formed, fly from one another with a great shock and noise, and circle in the air, so that no one can know or say whither they go, unless the same has been ascertained by experience as to the mode in which these spirits manifest.

Know then, gentle Reader, that life is the only true spirit, and that that which the ignorant herd look upon as dead may be brought back to permanent, visible, and spiritual life, if but the spirit be restored to the body -- the spirit which is supported by heavenly nutriment, and derived from heavenly, elementary, and earthly substances, which are also called formless matter. Moreover, as iron has its magnet which draws it with the invisible bonds of love, so our gold has its magnet, viz., the first Matter of the great Stone. If you understand these my words, you are richer and more blessed than the whole world.

Let me conclude this chapter with one more remark. When a man looks into a mirror, he sees therein reflected an image of himself. If, however, he try to touch it, he will find that it is not palpable, and that he has laid his hand upon the mirror only. In the same way, the spirit which must be evolved from this Matter is visible, but not palpable. This spirit is the root

of the life of our bodies, and the Mercury of the Philosophers, from which is prepared the liquid water of our Art - the water which must once more receive a material form, and be rectified by means of certain purifying agents into the most perfect Medicine. For we begin with a firm and palpable body, which subsequently becomes a volatile spirit, and a golden water, without any conversion, from which our Sages derive their principle of life. Ultimately we obtain the indestructible medicine of human and metallic bodies, which is fitter to be known to angels than to men, except such as seek it at God's hands in heartfelt prayer, and give genuine proofs of their gratitude by service rendered to Him, and to their needy neighbour.

Hereunto I may add, in conclusion, that one work is developed from another. First, our Matter should be carefully purified, then dissolved, destroyed, decomposed, and reduced to dust and ashes. Thereupon prepare from it a volatile spirit, which is white as snow, and another volatile spirit, which is red as blood. These two spirits contain a third, and are yet but one spirit. Now these are the three spirits which preserve and multiply life. Therefore unite them, give them the meat and drink that Nature requires, and keep them in a warm chamber until the perfect birth takes place. Then you will see and experience the virtue of the gift bestowed upon you by God and Nature. Know, also, that hitherto my lips have not revealed this secret to any one, and that God has endowed natural substances with greater powers than most men are ready to believe. Upon my mouth God has set a seal, that there might be scope for others after me to write about the wonderful things of Nature, which by the foolish are looked upon as unnatural. For they do not understand that all things are ultimately traceable to supernatural causes, but nevertheless are, in this present state of the world, subject to natural conditions.

SIXTH KEY

The male without the female is looked upon as only half a body, nor can the female without the male be regarded as more complete For neither can bring forth fruit so long as it remains alone. But if the two be conjugally united, there is a perfect body, and their seed is placed in a condition in which it can yield increase.

If too much seed be cast into the field, the plants impede each other's growth, and there can be no ripe fruit. But if, on the other hand, too little be sown, weeds spring up and choke it.

If a merchant would keep a clear conscience, let him give just measure to his neighbour. If his measure and weight be not short, he will receive praise from the poor.

In too much water you may easily be drowned; too little water, on the other hand, soon evaporates in the heat of the sun.

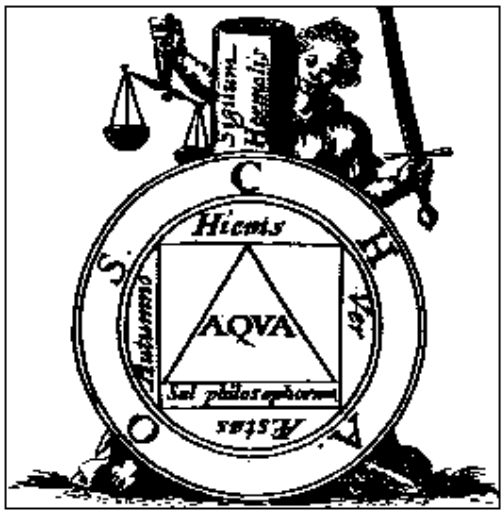
If, then, you would attain the longed-for goal, observe just measure in mixing the liquid substance of the Sages, lest that which is too much overpower that which is too little, and the generation be hindered. For too much rain spoils the fruit, and too much drought stunts its growth. Therefore, when Neptune has prepared his bath, measure out carefully the exact quantity of permanent water needed, and let there be neither too little nor too much.

The twofold fiery male must be fed with a snowy swan, and then they must mutually slay each other and restore each other to life; and the air of the imprisoned fiery male will occupy three of the four quarters of the world, and make up three parts of the imprisoned fiery male, that the death-song of the swans may be distinctly heard; then the swan roasted will become food for the King, and the fiery King will be seized with great love towards the Queen, and will take his fill of delight in embracing her, until they both vanish and coalesce into one body.

It is commonly said that two can overpower one, especially if they have sufficient room for putting forth their strength. Know also that there must come a twofold wind, and a single wind, and that they must furiously blow from the east and from the south. lf, when they cease to rage, the air has become water, you may be confident that the spiritual will also be transmuted into a bodily form, and that our number shall prevail through the four seasons in the fourth part of the sky (after the seven planets have exercised power), and that its course will be perfected by the test of fire in the lowest chamber of our palace, when the two shall overpower and consume the third.

For this part of our Magistery skill is needed, in order to divide and compound the substances aright, so that the art may result in riches, and the balance may not be falsified by unequal weights. The sky we speak of is the sky of our Art, and there must be justly proportioned parts of our air and earth, our true water and our palpable fire.

SEVENTH KEY



Natural heat preserves the life of man. If his body lose its natural heat his life has come to an end.

A moderate degree of natural heat protects against the cold; an excess of it destroys life. It is not necessary that the substance of the Sun should touch the earth. The Sun can heat the earth by shedding thereon its rays, which are intensified by reflection. This intermediate agency is quite sufficient to do the work of the Sun, and to mature everything by coction. The rays of the Sun are tempered with the air by passing through it so as to operate by the medium of the air, as the air operates through the medium of the fire.

Earth without water can produce nothing, nor can water quicken anything into growth without earth; and as earth and water are mutually indispensable in the production of fruit, so fire cannot operate without air, or air without fire. For fire has no life without air; and without fire air possesses neither heat nor dryness.

When its fruit is about to be matured, the vine stands in greater need of the Sun's warmth than in the spring; and if the Sun shine brightly in the autumn, the grapes will be better than if they had not felt his autumnal warmth.

In the winter the multitude suppose everything to be dead, because the earth is bound in the chains of frost, so that nothing is allowed to sprout forth. But as soon as the spring comes, and the cold is vanquished by the power of the Sun, everything is restored to life, the trees and herbs put forth buds, leaves, and blossoms, the hibernating animals creep forth from their hiding places, the plants give out a sweet fragrance, and are adorned with a great variety of many coloured flowers; and the summer carries on the work of the spring, by changing its flowers into fruit.

Thus, year by year, the operations of the universe are performed, until at length it shall be destroyed by its Creator, and all the dwellers upon earth shall be restored by resurrection to a glorified life. Then the operations of earthly nature shall cease, and the heavenly and eternal dispensation shall take its place.

When the Sun in the winter pursues his course far away from us, he cannot melt the deep snow. But in the summer he approaches nearer to us, the quality of the air becomes more fiery, and the snow melts and is transmuted by warmth into water. For that which is weak is always compelled to yield to that which is strong.

The same moderate course must be adopted in the fiery regimen of our Magistery. For it is all important that the liquid should not be dried up too quickly, and that the earth of the Sages should not be melted and dissolved too soon, otherwise your fishes would be changed into scorpions. If you would perform our task rightly, take the spiritual water, in which the spirit was from the beginning, and preserve it in a closely shut chamber. For the heavenly city is about to be besieged by earthly foes. You must, therefore, strongly fortify it with three impassable and well-guarded walls, and let the one entrance be well protected. Then light the lamp of wisdom and seek with it the gross thing that was lost, shewing only such light as is needed. For you must know that the worms and reptiles dwell in the cold and humid earth, while man has his proper habitation upon the face of the earth; the bodies of angels, on the other hand, not being alloyed with sin or impurity, are injured by no extreme either of heat or cold. When man shall have been glorified, his body will become like the angelic body in this respect. If we carefully cultivate the life of our souls, we shall be sons and heirs of God, and shall be able to do that which now seems impossible. But this can be effected only by the drying up of all water, and the purging of heaven and earth and all men with fire

EIGHTH KEY

Neither human nor animal bodies can be multiplied or propagated without decomposition; the grain and all vegetable seed, when cast into the ground, must decay before it can spring up again; moreover, putrefaction imparts life to many worms and other animalculae. The process of augmentation and quickening is mostly performed in [the] earth, while it is caused by spiritual seed through the other elements.

The farmer's wife knows that she cannot hope to obtain chickens except through the decomposition of the egg. If bread is placed in honeys and suffered to decay, ants are generated; worms are bred in the putrefying bodies of men, horses, and other animals; maggots are also developed by the decay of nuts, apples, and pears.

The same thing may be observed in regard to vegetable life. Nettles and other weeds spring up where no such seed has ever been sown. This occurs only by putrefaction. The reason is that the soil in such places is so disposed, and, as it were, impregnated, that it produces these fruits, which is a result of the properties of sidereal influence; consequently the seed is

spiritually produced in the earth, and putrefies in the earth, and by the operation of the elements generates corporeal matter according to the species of Nature. Thus the stars and the elements may generate new spiritual, and, ultimately, new vegetable seed, by means of putrefaction. But man cannot create new seed; for it is not in his power to order the operation of the elements and the essential influences of the stars. By natural conditions, however, new plants are generated simply through putrefaction. This fact is not noticed by the farmer, simply because it is a thing that he has always been used to, and for which he is unable to find an explanation. But you who should know more than the vulgar herd, must search into the causes of things, and endeavor to understand how the process of generation and resuscitation is accomplished by means of decomposition, and how all life is produced out of decay.

Each element is in its turn decomposed and regenerated by that which is contained in it. For you should know that every element contains the three others. In air, for instance, there is fire, water, and earth. This assertion may appear incredible, but it is nevertheless true. In like manner, fire includes air, water, and earth, since otherwise it could generate nothing. Water contains fire, air, and earth; for if it did not, there could be no growth. At the same time, each element is distinct, though each contains the others. All this is: found by distillation in the separation of the elements.

In order to rationally prove this to you, who are investigating the separation of Nature. and purpose to understand the division of the elements, lest you should think my words inventions, and not true, I tell you that if you distil earth, you will find that, first of all, there is an escape of air, which, in its turn, always contains fire, as they are both of a spiritual essence, and exercise an irresistible mutual attraction. In the next place, there issues water from the earth, and the earth, in which is the precious salt, remains by itself at the bottom of the vessel.

When water is distilled, air and fire issue from it, and the water and material earth remain at the bottom. Again, when the invisible part of elementary fire is extracted, you get water and earth by themselves. Nor can any of the three other elements exist without air. It is air that gives to earth its power of production, to fire its power of burning, to water its power of generating fruit. Again, air can consume nothing, nor dry up any moisture, without that natural heat which must be imparted to it by fire. For everything that is hot and dry contains fire. From these considerations we conclude that no element can exist without the others, and that in the generation of all things there is a mingling of the four elements. He who states the contrary in no wise understands the secrets of Nature, nor has he investigated the properties of the elements. For if anything is to be generated by putrefaction, the process must be as follows: The earth is first decomposed by the moisture which it contains; for without moisture, or water, there can be no true decay; thereupon the decomposed substance is kindled and quickened by the natural heat of fire: for without natural heat no generation can take place. Again, if that which has received the spark of life, is to be stirred up to motion and growth, it must be acted upon by air. For without air, the quickened substance would be choked and stifled in the germ. Hence it manifestly appears that no one element can work effectually without the aid of the others, and that all must contribute towards the generation of anything. Thus their quickening cooperation takes the form of putrefaction, without which there can be

neither generation, life, nor growth. That there can be no perfect generation or resuscitation without the co-operation of the four elements, you may see from the fact that when Adam had been formed by the Creator out of earth, there was no life in him, until God breathed into him a living spirit. Then the earth was quickened into motion. In the earth was the salt that is, the Body; the air that was breathed into it was mercury or the Spirit, and this air imparted to him a genuine and temperate heat, which was sulphur, or fire. Then Adam moved and by his power of motion, shewed that there had been infused into him a life-giving spirit. For as there is no fire without air so neither is there any air without fire. Water was incorporated with the earth Thus living man is an harmonious mixture of the four elements; and Adam was generated out of earth, water, air, and fire, out of soul, spirit, and body, out of mercury, sulphur, and salt.

In the same way, Eve, our common mother, was created; for her body was built up and formed out of Adam's body - a fact which I wish you particularly to notice.

To return again to putrefaction, O seeker of the Magistery and devotee of philosophy, know that, in like manner, no metallic seed can develop, or multiply, unless the said seed, by itself alone, and without the introduction of any foreign substance, be reduced to a perfect putrefaction.

The putrefaction of metallic seed must, like that of animal and vegetable seed, take place through the co-operation of the four elements. I have already explained that the elements themselves are not the seed. But it ought by this time to be clear to you that the metallic seed which was produced by the combined operation of heavenly, sidereal, and elementary essences, and reduced into bodily form, must, in due course, be corrupted and putrefied by means of the elements.

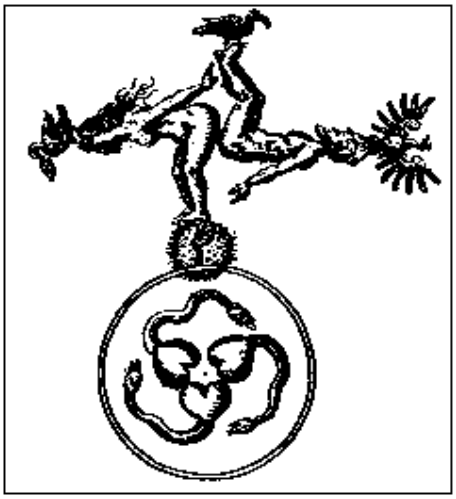
Observe that this seed contains a living volatile spirit. For when it is distilled, there issues from it first a spirit, and then that which is less volatile. But when by continued gentle heat, it is reduced to an acid, the spirit is not so volatile as it was before. For in the distillation of the acid the water issues first, and then the spirit. And though the substance remains the same, its properties have become very different. It is no longer wine, but has been transmuted by the putrefaction of gentle heat into an acid. That which is extracted with wine or its spirit, has widely different properties and powers from that which is extracted with an acid. For if the crystal of antimony be extracted with wine or the spirit of wine, it causes vomiting and diarrhoea, because it is a poison, and its poisonous quality is not destroyed by the wine. But if it be extracted with a good distilled acid, it furnishes a beautiful extract of a rich colour. If the acid be removed by means of the St. Mary's Bath, and the residuum of yellow powder washed away, you obtain a sweet powder which causes no diarrhoea, but is justly regarded as a marvellously beneficial medicine.

This excellent powder is dissolved in a moist place into a liquid which is profitably employed as a painless agent in surgery.

Let me sum up in few words what I have to say. The substance is of heavenly birth, its life is preserved by the stars, and nourished by the four elements; then it must perish, and be putrefied; again, by the influence of the stars, which works through the elements, it is restored to life, and becomes once more a heavenly thing that has its habitation in the highest region of the firmament. Then you will find that

the heavenly has assumed an earthly body, and that the earthly body has been reduced to a heavenly substance.

NINTH KEY



Saturn, who is called the greatest of the planets, is the least useful in our Magistery. Nevertheless, it is the chief Key of the whole Art, howbeit set in the lowest and meanest place. Although by its swift flight it has risen to the loftiest height, far above all other luminaries, its feathers must be clipped, and itself brought down to the lowest place, from whence it may once more be raised by putrefaction, and the quickening caused by putrefaction, by which the black is changed to white, and the white to red, until the glorious colour of the triumphant King has been attained. Therefore, I say that though Saturn may seem the vilest thing in the world, yet it has such power and effficacy that if its precious essence, which is excessively cold, be reduced to a metallic body by being deprived of its volatility, it becomes as corporeal as, but far more fixed than, Saturn itself. This transmutation is begun, continued, and completed with Mercury, sulphur, and salt. This will seem unintelligible to many, and it certainly does make an extraordinary demand upon the mental faculties; but that must be so because the substance is within the reach of everyone, and there is no other way of keeping up the divinely ordained difference between rich and poor.

In the preparation of Saturn there appears a great variety of different colours; and you must expect to observe successively black, grey, white, yellow, red, and all the different intermediate shades. In the same way, the Matter of all the Sages passes through the several varieties of colour, and may be said to change its appearance as often as a new gate of entrance is opened to the fire.

The King shares his royal dignity with noble Venus, and appears in splendid state, surrounded by all the dignitaries of his court. Before him is borne a beautiful crimson banner, in which there is an embroidered representation of Charity in green garments. Saturn is the prefect of the royal household, and in front of him Astronomy bears a black standard, with a representation of Faith in yellow and red garments.

Jupiter is the Grand Marshal, and is preceded by a banner of grey colour, borne by Rhetoric, and adorned with a variegated representation of Hope.

Mars is at the head of military affairs, and executes his office with a certain fiery ardour. Geometry carries before him a

crimson banner, on which you may behold Courage in a crimson cloak. Mercury holds the office of Chancellor; Arithmetic is his standard bearer, and his standard is of many colours; on it may be observed the figure of Temperance in a many coloured robe.

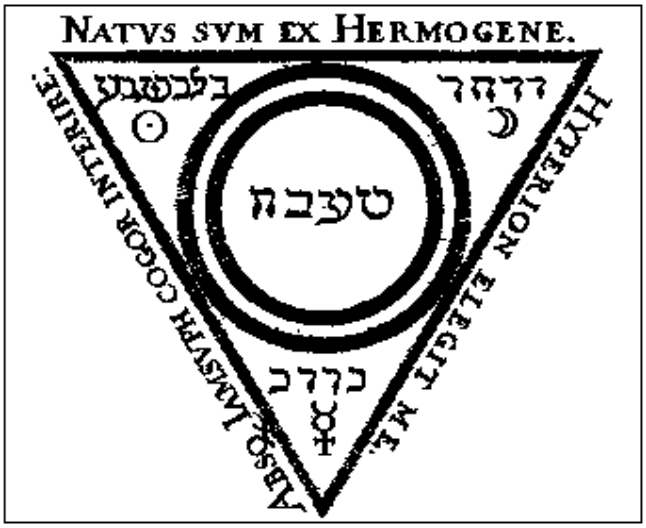
The Sun is Vice-Regent, and is preceded by Grammar, bearing a yellow banner, on which Justice is represented in a golden robe Though Venus seems to cast him into the shade by the gorgeous magnificence of her appearance, he really possesses more power in the kingdom than she.

Before the Moon, Dialectic bears a shining silver banner, with the figure of Prudence wrought into it in sky-blue, and because the husband of the Moon is dead, he has transferred to her his task of resisting the domination of Queen Venus. For among all these there is enmity, and they are all striving to supplant each other. Indeed, the tendency of events is to give the highest place to the most excellent and the most deserving. For the present state of things is passing away, and a new world is about to be created, and one Planet is devouring another spiritually, until only the strongest survive.

Let me tell you allegorically that you must put into the heavenly Balance the Ram, Bull, Cancer, Scorpion, and Goat. In the other scale of the Balance you must place the Twins, the Archer, the Water-bearer, and the Virgin. Then let the Lion jump into the Virgin's lap, which will cause the other scale to kick the beam. Thereupon, let the signs of the Zodiac enter into opposition to the Pleiads, and when all the colours of the world have shewn themselves, let there be a conjunction and union between the greatest and the smallest, and the smallest and the greatest.

If the whole world's nature
Were seen in one figure,
And nothing could be evolved by Art,
Nothing wonderful would be found in the Universe,
And Nature would have nothing to tell us.
For which let us laud and praise God.

TENTH KEY



In our Stone, as composed by me and by those who have long preceded me, are contained all elements, all mineral and metallic forms, and all the qualities and properties of the whole world. In it we find most powerful natural heat, by which the icy body of Saturn is gently transmuted into the

best gold. It contains also a high degree of cold, which tempers the fervent heat of Venus, and coagulates the mercury, which is thereby also changed into the finest gold. All these properties slumber in the substance of our Stone, and are developed, perfected, and matured by the gentle coction of natural fire, until they have attained their highest perfection. If the fruit of a tree be plucked before it is ripe, it is unfit for use; and if the potter fail to harden his vessels in the fire, they cannot be employed for any good purpose.

In the same way you must exercise considerable patience in preparing our Elixir, if it is to become all that you wish it to become. No fruit can grow from a flower that has been plucked before the time. He who is in too great a hurry, can bring nothing to perfection, but is almost sure to spoil that which he has in hand. Remember, then, that if our Stone be not sufficiently matured, it will not be able to bring anything to maturity.

The substance is dissolved in a bath, and its parts reunited by putrefaction. In ashes it blossoms. In the form of sand all its excessive moisture is dried up. Maturity and fixity are obtained by living fire. The work does not actually take place in the Bath of St. Mary, in horse- dung, in ashes, or in sand, but the grades and regimen of the fire proceed after the degrees which are represented by these The Stone is prepared in an empty furnace, with a threefold line of circumvallation, in a tightly closed chamber. It is subjected to continued coction, till all moisture and clouds are driven off, and the King attains to indestructible fixedness, and is no longer liable to any danger or injury, because he has become unconquerable. Let me express my meaning in a somewhat different manner. When you have dissolved your earth with your water, dry up the water with its own inward fire. Then the air will breathe new life into the body, and you will have that which can only be regarded as that Great Stone which in a spiritual manner pervades human and metallic bodies, and is the universal and immaculate Medicine, since it drives out that which is bad, and preserves that which is good, and is the unfailing corrective of all imperfect or diseased substances. This Tincture Is of a colour intermediate between red and purple, with something of a granite hue, and its specific weight is very considerable.

Whoever gains possession of this Stone, should let his whole life he an expression of his gratitude towards God in practical kindness towards his suffering brethren, that after obtaining God's greatest earthly gift, he may hereafter inherit eternal life. Praise be unto God everlastingly for this His inestimable gift.

ELEVENTH KEY

The eleventh Key to the Knowledge of the augmentation of our Stone, I will put before you in the form of a parable.

There lived in the East a gilded knight, named Orpheus, who was possessed of immense wealth, and had everything that heart can wish. He had taken to wife his own sister, Euridice, who did not, however, bear him any children. This he regarded as the punishment of his sin in having wedded his own sister, and was instant in prayer to God both by day and by night, that the curse might be taken from him.

One night, when he was buried in a deep sleep, there came to him a certain winged messenger, named Phoebus, who touched his feet, which were very hot, and said: " Thou noble knight, since thou hast wandered through many cities and kingdoms, and suffered many things at sea, in battle, and in the lists, the heavenly Father has bidden me make known to thee the following means of obtaining thy prayer: Take blood from thy right side, and from the left side of thy spouse. For this blood is the heart's blood of your parents, and though it may seem to be of two kinds, vet, in reality, it is only one. Mix the two kinds of blood, and keep the mixture tightly enclosed in the globe of the seven wise Masters There that which is generated will be nourished with its own flesh and blood, and will complete its course of development when the Moon has changed for the eighth time If thou repeat this process again and again, thou shalt see children's children, and the offspring of thy body shall fill the world."

When Phoebus had thus spoken, he winged his flight heavenward. In the morning the knight arose and did the bidding of the celestial messenger, and God gave to him and to his wife many children, who inherited their father's glory, wealth, and knightly honours from generation to generation.

If you are wise, my son, you will find the interpretation of my parable. If you do not understand it, ascribe the blame not to me, but to your own ignorance. I may not express myself more explicitly; indeed, I have revealed the matter in a more plain and straightforward manner than any of my predecessors. 1 have concealed nothing; and if you will but remove the veil of ignorance from your eyes, you will behold that which many have sought and few found.

TWELFTH KEY

If an athlete know not the use of his sword, he might as well be without it; and if another warrior that is skilled in the use of that weapon come against him, the first is like to fare badly. For he that has knowledge and experience on his side, must carry off the victory.

In the same way, he that possesses this tincture, by the grace of Almighty God, and is unacquainted with its uses, might as well not have it at all. Therefore this twelfth and last Key must serve to open up to you the uses of this Stone. In dealing with this part of the Subject I will drop my parabolic and figurative style, and plainly set forth all that is to be known. When the Medicine and Stone of all the Sages has been perfectly prepared out of the true virgin's milk, take one part of it to three parts of the best gold purged and refined with antimony, the gold being previously beaten into plates of the greatest possible thinness. Put the whole into a smelting pot and subject it to the action of a gentle fire for twelve hours, then let it be melted for three days and three nights more.

For without the ferment of gold no one can compose the Stone or develop the tinging virtue. For the same is very subtle and penetrating if it be fermented and joined with a ferment like unto itself: then the prepared tincture has the power of entering into other bodies, and operating therein. Take then one part of the prepared ferment for the tinging of a thousand parts of molten metal, and then you will learn in all faith and truth that it shall be changed into the only good and fixed gold. For one body takes possession of the other; even if it be unlike to it, nevertheless, through the strength and potency added to it, it is compelled to be assimilated to the same, since like derives origin from like.

Whoever uses this as a medium shall find whither the vestibules of the palace lead, and there is nothing comparable to the subtlety thereof. He shall possess all in all, performing all things whatsoever which are possible under the sun.

O principle of the prime principle, consider the end! O end of the final end, consider the beginning! And be this medium commended unto your faithful care, wherein also God the Father, Son, and Holy Ghost, shall give unto you whatsoever you need both in soul and body.

Concerning the First Matter of the Philosophical Stone

Seek for that Stone which has no fleshly nature, but out of

which a volatile fire is extracted, whence also this stone is made, being composed of white and red. It is a stone, and no stone; therein Nature alone operates. A fountain flows from it. The fixed part submerges its father, absorbing it, body and life, until the soul is returned to it. And the volatile mother like to him, is produced in her own kingdom; and he by his virtue and power receives greater strength. The volatile mother when prepared surpasses the sun in summer. Thus the father by means of Vulcan was produced from the spirit. Body, soul, and spirit exist in both, whence the whole matter proceeds. It proceeds from one, and is one matter. Bind together the fixed and the volatile; they are two, and three, and yet one only. If you do not understand you will attain nothing. Adam was in a bath -- wherein Venus found her like, which bath the aged Dragon had prepared when his strength was deserting him. There is nothing, says the Philosopher, save a double mercury; I say that no other matter has been named; blessed is he who understands it. Seek therein, and be not weary; the result justifies the labour.

A short Appendix and clear Resumption of the foregoing Tract concerning the Great Stone of the Ancient Sages

I, Basil Valentine, brother of the Benedictine Order, do testify that I have written this little book, wherein, after the manner of the Ancients, I have philosophically indicated how this most rare treasure may be acquired, whereby the true Sages did prolong life unto its furthest limit.

But, notwithstanding that my conscience doth bear me witness in the sight of the Most High, before whom all concealed matters are laid bare, that I have written no falsehood, but have so exposed the truth that understanding men can require no further light (that which is laid down in the theoretical part being borne out and confirmed by the practice of the Twelve Keys), yet have I been impelled by various considerations to demonstrate by a shorter way what I have written in the said treatise, and thus cast further light thereon, whereby also the lover of the desired wisdom may obtain an increased illumination for the fulfilment of his desire There are many who will consider that I am speaking too openly, and will hold me answerable for the wickedness that they think will follow, but let them rest assured that it will be sufficiently difficult, notwithstanding, for any thick-headed persons to find what they seek herein. At the same time the matter shall be made clear to the elect. Hearken then, thou follower of truth, to these my words, and so shalt thou find the true way !

Behold, I write nothing more than I am willing to hold by after my death and resurrection! Do thou faithfully and simply lay to heart this shorter way, as hereinafter exhibited, for my words are grounded in simplicity, and my teaching is not confused by a labyrinth of language.

I have already indicated that all things are constituted of three essences - namely, mercury, sulphur, and salt - and herein I have taught what is true. But know that the Stone is composed out of one, two, three, four, and five. Out of five - that is, the quintessence of its own substance. Out of four, by which we must understand the four elements. Out of three, and these are the three principles of all things. Out of two, for the mercurial substance is twofold. Out of one, and this is the first essence of everything which emanated from the primal fiat of creation.

But many may by all these discourses be rendered doubtful in mind as to what they must start with, and as to the consequent theory. So I will, in the first place, speak very briefly concerning Mercury, secondly concerning Sulphur, thirdly concerning Salt; for these are the essence of the Matter of our Stone.

In the first place, you must know that no ordinary quicksilver is useful, but our quicksilver is produced from the best metal by the spagyric art, pure, subtle, clear, and glistening, like a spring, pellucid even as crystal, free from all dross. Hence make water or combustible oil. For Mercury was in the beginning water, and herein all the Sages agree with my dictum and teaching In this oil of Mercury dissolve its own Mercury, from which the water in question was made, and precipitate the Mercury with its own oil. Then we have a twofold mercurial substance; but you must know that gold must first be dissolved in a certain water, as explained in my second Key, after the purification described in the first Key, and must be reduced into a subtle calx, as is mentioned in the fourth Key. Next, this calx must be sublimated by the spirit of salt, again precipitated, and by reverberation reduced into a subtle powder. Then its own sulphur can more easily enter into its substance, and have great friendship with the same, for they have a wondrous love towards each other. Thus you have two substances in one, and it is called Mercury of the Sages, but is yet a single substance, which is the first ferment.

Now follows concerning Sulphur

Seek your Mercury in a similar metal. Then when you know how to extract the metal from its body by purification, the destruction of the first Mars, and reverberation, without the use of any corrosive (the method of doing which I have indicated in my third Key) -- you must dissolve that Mercury in its own blood out of which it was made before it became fixed (as indicated in the sixth Key); and you have then nourished and dissolved the true lion with the blood of the green lion. For the fixed blood of the Red Lion has been made out of the volatile blood of the Green Lion; hence, they are of one nature, and the unfixed blood again renders that which is volatile fixed, and the fixed blood in its turn fixes that which is volatile, as it was before its solution. Then foster it in gentle heat, until the whole of the mercury is dissolved, and you obtain the second ferment (by nourishing the fixed sulphur with that which is not fixed), as all Sages unite with me in testifying. Afterwards this becomes, by sublimation with spirit of wine, of a blood-red colour, and is called potable gold.

Now I will also give my Opinion respecting the Salt of the Sages

The effect of "salt" is to fix or volatilize, according as it is prepared and used. For the spirit of the salt of tartar, if extracted by itself without any addition, has power to render all metals volatile by dissolution and putrefaction, and to dissolve quick or liquid silver into the true mercury, as my practical directions shew.

Salt of tartar by itself is a powerful fixative, particularly if the heat of quicklime be incorporated with it. For these two substances are singularly efficacious in producing fixation.

In the same way, the vegetable salt of wine fixes and volatilizes according to the manner of its preparation. Its use

is one of the arcana of Nature, and a miracle of the philosopher's art. When a man drinks wine, there may be gained from his urine a clear salt, which is volatile, and renders other fixed substances volatile, causing them to rise with it in the alembic. But the same does not fix. If a man drank nothing but wine, yet for all that the salt obtained from his urine would have a different property from that gained out of the lees of wine. For it has undergone a chemical change in the human body, having become transmuted from a vegetable into an animal salt -- just as horses that feed on oats, straw, etc., change those vegetable substances into flesh and fat, while the bee prepares honey out of the precious juices of flowers and herbs.

The great change which takes place in these and other substances is due to putrefaction, which separates and transmutes the constituent elements.

The common spirit of salt, which is extracted according to the direction given in my last declaration, if there be added to it a small quantity of the "spirit of the dragon," dissolves, volatilizes, and raises together with itself in the alembic, gold and silver; just as the "eagle," together with the spirit of the dragon (which is found in stony places), before the spirit is separated from its body, is much more powerful in producing fixation than volatility.

This I also say, that if the spirit of common salt be joined to the spirit of wine, and distilled together with it, it becomes sweet, and loses its acidity. This prepared spirit does not dissolve gold bodily, but if it be poured on prepared calx of gold, it extracts the essence of its colour and redness. If this be rightly done, it reduces the white and pure moon to the colour of that body from which it was itself extracted. The old body may also receive back its former colour through the love of alluring Venus, from whose blood it, in the first instance, derived its origin.

But observe, likewise, that the spirit of salt also destroys the moon, and reduces it to a spiritual essence, according to my teaching, out of which the " potable moon " may be prepared. This spirit of the moon belongs to the spirit of the sun, as the female answers to the male, by the copulation or conjunction of the spirit of mercury or its oil.

The spirit lies hid in mercury, the colour you must seek in sulphur, and their coagulation in salt; then you have three things which together are capable of once more generating a perfect thing. The spirit is fermented in the gold with its own proper oil; the sulphur is found in abundance in the property of precious Venus. This kindles the fixed blood which is sprung from it, the spirit of the salt of the Sages imparts strength and firmness, though the spirit of tartar and the spirit of urine together with true vinegar, have great virtue. For the spirit of vinegar is cold, and the spirit of lime is intensely hot, and thus the two spirits are found to be of opposite natures. I do not here speak according to the customary manner of the Sages. But I must not say too openly how the inner gates are to be unlocked.

In bidding farewell, let me impart to you a faithful word. Seek your material in a metallic substance. Thence prepare mercury. This ferment with the mercury of its own proper sulphur, and coagulate them with salt. Distil them together; mix all according to weight. Then you will obtain one thing, consisting of elements sprung from one thing. Coagulate and fix it by means of continuous warmth. Thereupon augment and ferment it a third time, according to the teaching of my

two last Keys, and you will find the object and goal of your desire. The uses of the Tincture are set forth plainly in my twelfth Key.

Thanks be to God.

As a parting kindness to you, I am constrained to add that the spirit may also be extracted from black Saturn and benevolent Jupiter. When it has been reduced to a sweet oil, we have a means of robbing the common liquid quicksilver of its vivacity, or rendering it firm and solid, as is also set forth in my book.

Postscript

When you have thus obtained the material, the regimen of the fire is the only thing on which you need bestow much attention. This is the sum and the goal of our search. For our fire is a common fire, and our furnace a common furnace. And though some of my predecessors have left it in writing that our fire is not common fire, I may tell you that it was only one of their devices for hiding the mysteries of our Art. For the material is common, and its treatment consists chiefly in the proper adjustment of the heat to which it is exposed.

The fire of a spirit lamp is useless for our purpose. Nor is there any profit in "horse-dung," nor in the other kinds of heat in the providing of which so much expense is incurred.

Neither do we want many kinds of furnaces. Only our threefold furnace affords facilities for properly regulating the heat of the fire. Therefore do not let any babbling sophist induce you to set up a great variety of expensive furnaces. Our furnace is cheap, our fire is cheap, and our material is cheap - and he who has the material will also find a furnace in which to prepare it, just as he who has flour will not be at a loss for an oven in which it may be baked. It is unnecessary to write a special book concerning this part of the subject. You cannot go wrong, so long as you observe the proper degree of heat, which holds a middle place between hot and cold. If you discover this, you are in possession of the secret, and can practise the Art, for which the CREATOR of all nature be praised world without end. AMEN.

Educational Resources

- Chymical Products
- **Experiments in Mineral Acids**
- Multimedia Lab
- Related Websites

Experiments in Mineral Acids

Mineral acids were some of the most frequently used substances in Newton's chymistry. These included "oyl of vitriol" (sulfuric acid), "aqua fortis" (nitric acid), and "spirit of salt" (hydrochloric acid), in addition to various combinations of these such as "aqua regia" (nitric acid & hydrochloric acid). Drawing from the works on "strong waters" of Islamic alchemists such as Jabir ibn Hayyan (c. ninth-tenth century) and Abu Bakr Muhammad ibn Zakariya' al-Razi (c. 865-925), medieval alchemists and physicians were the first to produce concentrated acids from the distillation of minerals (Robert Multhauf, The Relationship Between Technology and Natural Philosophy, ca. 1250-1650, as Illustrated by *Technology of the Mineral Acids* (Ph.D. Dissertation, University of California, 1953), pp. 140-141). Newton describes these acids and the method for making them in the manuscript Oxford University, Bodleian Library Don b. 15.

The "Oyl of Vitriol"

Don b. 15 pp.4r & 7r:

> "Oyle of Vitrioll is acid destild from vitrioll first calcined to whitenesse for feare of boyling over when it <illeg.> . The fumes are white but sattle into this reddish liquor."

Newton has another description of the process in the same manuscript on p.8v:

> "Spt of Vitrioll & Oyle. Deflegm ye vitrioll &c a <illeg> yt circulatory fire till after melting it coagulate into a grayish lump wch is done in 2 howers. A glass retort half filld wth this poudered, & urged into a large receiver till black veines begin to trickle downe. Then change ye receiver but lute it not on. A pound yeilds 9 or 10 ℥ss cs of transparent spirit, 1 1/2 ℥ss of black oyle, & ye remaining colcothar (caput mortuum) conteins a fixed salt of ♀♀. The spt & oyle differ but in their flegm: ffor a drachm of spt dropt into common water ℥ss i, & filtered makes ye spt."

The English chymist and physician John French (1616-1657) described a similar method for the production of oil of vitriol, and he also included a picture of the apparatus used for distilling various mineral acids.

French describes the process as follows:

> "Take of Hungarian, or the best English Vitrial, as much as you please, let it be melted in an earthen vessell glazed, with a soft fire, that all the moisture may exhale, continually stirring of it, untill it be brought into a yellow powder, which must be put into a glasse Retort well luted, or an earthen Retort that will endure the fire: Fit a large Receiver to the Retort and close the joints wel together; then give it fire by degrees till the second day, then make the strongest heat you can til the Receiver which before was dark with fumes be clear again; let the Liquor that is distilled off be put into a little Retort, and the flegm be drawn off in sand, so will the oil be rectified, which is most strong and ponderous, and must be kept by it self."

Fig. 1: French's furnace and distillation apparatus. *The Art of Distillation* (London, 1653), p.64.

In our reproduction of Newton's method for making the oil of vitriol, we constructed a temporary furnace using a steel tabletop barbecue surrounded by insulating firebrick. For a fuel source we used 100% natural hardwood charcoal. We used a specially made Pyrex retort and passed the condensing arm through a bucket of ice into a receiving flask. As per Newton's instructions, we did not seal the receiving flask to the retort.

We "dephlegmed" our vitriol ($FeSO_4 \cdot 7H_2O$) in a glass crystallizing dish on a hotplate until the material ceased evolving steam, had lost its green and blue color, and appeared a greyish yellow. After allowing the material to cool, we placed it in the glass retort and began heating in the fire.

Fig. 2: The furnace and the distilling apparatus.

Fig. 3: The initial color of the material.

Shortly after the temperature reached 400° C as measured by a thermocouple probe rated to 1000° C the color of the ferrous sulphate began to change to red. This is the temperature at which ferrous sulphate decomposes.

Fig. 4: Color change in the ferrous sulphate.

We immediately began to evolve a clear, acidic vapor, which we measured using standard pH paper (0-14). The approximate value of the pH of the vapor was zero.

Fig. 5: Acidic vapor collected in the receiving flask.

After proceeding with the distillation for approximately 4 hours at increased temperatures (the highest was near 1000°C), the evolution of vapor slowed and we ceased to collect acid. The product obtained was a clear, highly acid liquid with a pungent (and painful) odor.

Fig. 6: Test tubes filled with our "oyl of vitriol."

Some water from our condenser seeped into the receiving flask and diluted our acid, so we concentrated it using a traditional alchemical "Alembic." After removing the excess water from the acid, the product was more viscous and had a measured pH of zero.

Fig. 7: The Alembic used to distill off the sulfuric acid. The white material is teflon tape used to stop leakage at the middle joint.

After the glass retort had cooled, we observed that the fire had been hot enough to deform the Pyrex retort. The ferrous sulphate touching the bottom of the retort had turned bright red, but the other material was a greyish white.

Fig. 8: The slightly deformed bottom of our Pyrex retort and the red color of the material.

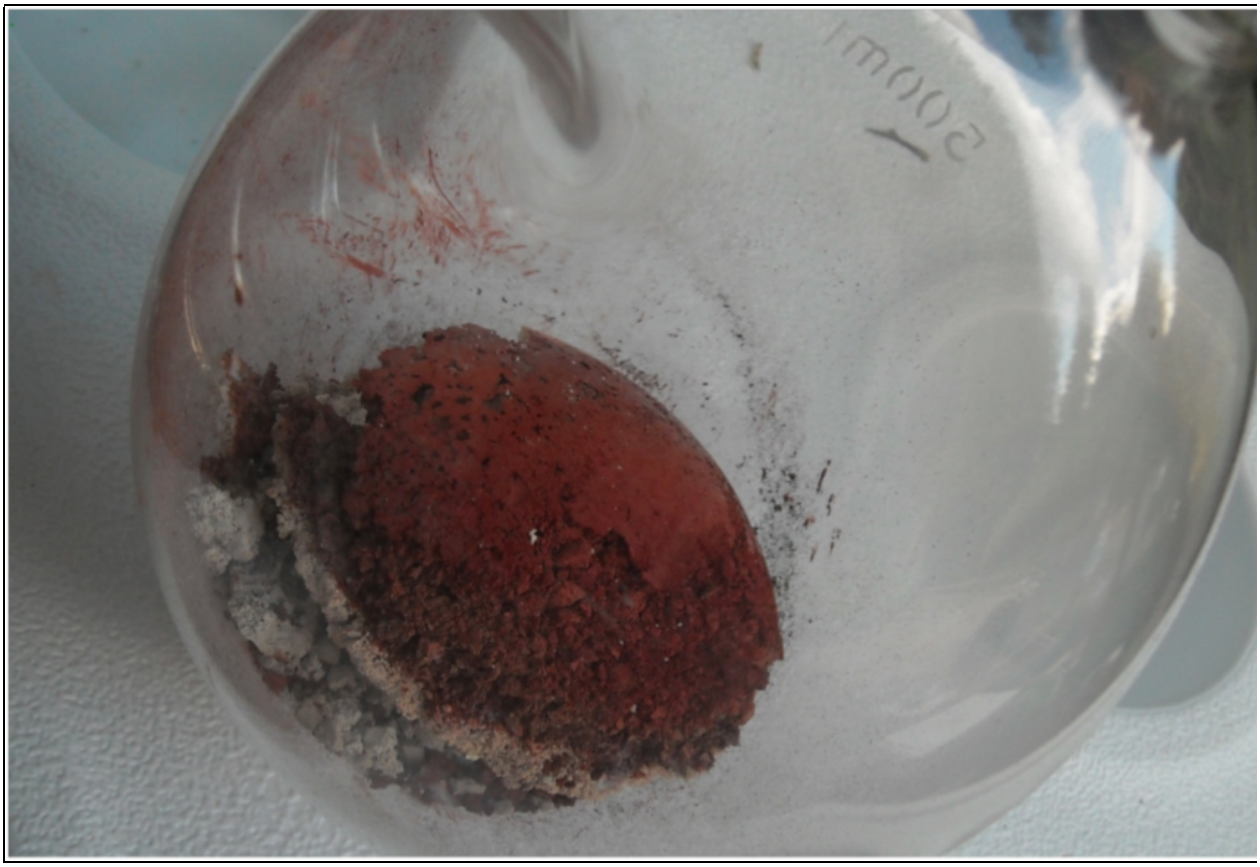


Fig. 9: Showing the material on the inside of the retort after it had been flipped over. The red material had been touching the wall of the retort.

"Aqua Fortis"

Newton describes the production of aqua fortis in Don b. 15, p.1r:

> "Aqua fortis is acid is distilled from one ℔te of Salt peeter well mixed wth two ℔ts of Vitriol well calcined to white. The fumes are red but settle into this cleer liquor. It differs very little from spirit of Niter, for ye Vitriol yeilds little or nothing but is only added to keep ye Niter from <flux>ing; for Salt & Salt peeter yeild noe spirit while they are in flux. It dissolves all mettalls <bu>t Gold. It may bee also drawne from a soluti<on> of one part of Salt peeter mixed wth one part of Oyle of Vitriol <illeg.> the caput mortuum will afford a white salt &c."

John French has a similar description in his 1653 The Art of Distillation:

> "Take of vitriol calcined two parts and of nitre one part. Grind and mix them well together and put them into a glass retort coated or earthen retort that will endure the fire. Set them into the furnace in an open fire and then, having fitted a large receiver, distill it by degrees the space of 24 hours. Then rectify the water or spirit in sand."

We began our distillation of aqua fortis with a similar apparatus as that used in our distillation of sulfuric acid. The furnace was practically identical (made from the tabletop barbecue and the firebrick, using natural charcoal as fuel), but instead of the glass retort and the ice condenser we used a 500mL roundbottom flask, a distilling adapter, a 400mm West condenser, and a large Erlenmeyer as a receiving flask. We cycled water through the condenser for the duration of the experiment.

Fig. 1: The furnace and our distillation apparatus.

As per Newton's description, we used two parts of calcined ferrous sulfate and one part potassium nitrate. We began heating the vessel and shortly after the temperature had reached approximately 500°C, we observed a red gas forming in the round bottom and the distillation adapter.

Fig. 2: The formation of red gas.

This gas was very likely NO_2. The gas filled the whole apparatus and some of the material began to assume liquid form (presumably as the gas combined with water in the air).

Fig. 3: Red gas in the receiving flask.

Fig. 4: Red gas filling the entire apparatus.

We continued the distillation for approximately four hours, until it appeared that gas was no longer evolving. We collected the liquid acid in several vials but allowed the gas remaining in the receiving flask to sit overnight. Both the liquid and the vapor had a pH of zero (as measured with 0-14 pH paper).

Fig. 5: Yellow-red aqua fortis.

Fig. 6: Acidic vapor collected in the receiving flask.

"Spirit of Salt"

Newton describes the production of the spirit of salt (hydrochloric acid) in Don b. 15, p.8v, as follows: "Spirit of Salt. Common salt, beat fine in 1 part brick-dust or potters earth not over dryed & pouder 5 parts : urge by a graduall fire out of a glass retort filld full into a large receiver till you feel the receiver cold & one pound will yeild nine or 10 ounces."

John French describes this process in much the same way: "Take one part of salt and three parts of powder of bricks or tiles, mix them together, and put them into a retort either of glass or earth, to which put fire as before. After this manner you may make oil or spirit of nitre, salt gem, alum. Note that these salts must first be calcined which is done by exhaling their phlegm."

Newton's description of the ratio of fuller's earth to salt was difficult to understand, so we chose instead to use French's ratio of three parts fuller's earth (cosmetic clay) to one part sea salt (purchased at a local health-food store). We used the same apparatus as the above aqua fortis distillation, but tried for a higher temperature as sodium chloride decomposes at 801°C.

Fig. 1: Spirit of salt furnace and distillation apparatus.

By stacking our firebricks higher and using a larger amount of coal we were able to achieve higher temperatures, reaching and perhaps surpassing 1000°C according to our thermocouple (only rated to 1000°C). The distillation yielded a white, pungent gas and a clear, acidic liquid. We continued the distillation until liquid and gas ceased to evolve, but attempted to distill more product by making the fire very hot.

Fig. 2: Concentrated hydrochloric acid (pH = 0).

During the distillation the glass appeared to be warping from the heat. After the distillation was finished and the glass had cooled, we observed that the Pyrex round bottom flask had been significantly melted by the fire.

Fig. 3 & 4: The melted round bottom flask.

V.I.T.R.I.O.L

Visita Interiora Terrae Rectificando Invenies Occultum Lapidem," which means "Visit the interior of the earth, and by rectifying (correcting or purifying) what you find there, you will discover the hidden stone.

copperas/ferrous sulfate/green vitriol

What is hungarian vitriol? mars and venus (copper and iron)

Copper-iron sulfide is chalcopyrites

weathering of iron and other pyrites:

From: http://www.juliantrubin.com/encyclopedia/chemistry/copperas.html

Copperas is crude ferrous sulfate, and was formerly known as green copperas to distinguish it from white copperas - zinc sulfate, blue copperas and copper sulfate.

Making copperas was a vast industry here in Britain from the 1600's till the late 1800's. It was sited along those areas of the coast - Kent, Essex, the Thames estuary and elsewhere, where there are still abundant supplies of pyrites

(or more probably, marcasite) from the Lias and other clays of the costal cliffs. It is not the golden nuggets of mineral collectors and museums, but rather, a dull black pebble, which is remarkably heavier than other pebbles as it contains a lot of iron. Only when smashed with a hammer does its true nature become evident - the grey-green metallic lustre of the fresh surface, and a slight smell of sulfur.

From copperas you can make ink, sulfuric acid, hydrochloric and nitric acids, aqua regia, jeweller's rouge, and Venetian Red, and thus it formed the basis of the earliest chemical industry.

The process for making copperas is the weathering of iron pyrites, as practiced in Nordhausen in Germany as the first stage in the process for making the famous Nordhausen sulfuric acid. The same process was practiced along the Thames estuary, probably brought to England by Flemish settlers. On an industrial scale, large pits, the size of tennis courts, and about fifteen feet deep were lined with timber. A channel at the bottom allowed liquors to run into a cistern. These pits were partly filled with the abundant local pyrites, and simply left in the sun, wind and rain to weather for two or three years. From time to time the liquors were run into the cistern, then boiled down. The concentrated solution would deposit on cooling, green crystals of copperas - ferrous sulfate - FeSO4.7H2O. A greater yield could be obtained by adding scrap iron to the hot solution. The crystals were often gathered on twigs, where they formed like barley sugar. Because big crystals look like green glass, it is also known as green vitriol. Roasting this gives off white fumes of sulfur trioxide, which can be condensed to strong sulfuric acid. This is a heavy oil-like liquid, hence its old name of Oil of Vitriol. But it's not an oil, for it doesn't float on water. Instead it mixes with water vigorously releasing a lot of heat.

My home process consists of putting a layer of iron pyrites nodules into the bottom of a plastic bucket, just covering with RAIN water, and allowing the contents to stand and evaporate in a warm room - or outdoors in the summer heat, for several weeks. My first attempt didn't work quickly - all I got after several weeks was a pale rusty solution, which was slightly acidic, and tasted metallic. I don't know if this is due to an inherent time lag before the process gets started, or else because I'd used chlorinated tap water, or else had put in too much water. In disgust, I transferred my experiment from the attic to my back yard over the summer. Some weeks later I peered inside. To my surprise and delight, the black nodules were all covered with a white and green encrustation - I'd made copperas - accidentally! Since then I've made a lot, from the same nodules. The process depends on the decomposition of pyrite - FeS2, not by atmospheric oxygen as it states in old chemistry books, but by bacteria - Thiobacillus Ferrioxidans and similar. These extremeophile organisms eat pyrites depositing ferrous sulfate as a waste product. The organisms have been living inside the nodules in a latent state for thousands or perhaps millions of years, and presumably need warmth, air and fresh water to waken up from their dormant state.

Though I've used pyrites nodules I gathered myself from Lias clays near

Lyme Regis, which are black on the outside, I suspect the process will work with any form of pyrites. My golden nuggets which mostly come from South America are too expensive to ruin in such an experiment, but probably would work just as well. Pyrites is a very common mineral - the gold streaks found in coal are made of it ("coal brasses") and most metalliferous mine tips will provide adequate supplies - look for the rocks which are particularly rusty. Any geologist will be glad to point out local sources, and usually provide you with free samples. Pyrites, the plural, is the name used by chemists, geologists nowadays tend to use the singular, pyrite.

The encrustation on the pebbles is a layer of beautiful white needles up to 5 mm long. Underneath is a moist layer of pale green ferrous sulfate - looking like grains of green sugar. When the mixture dries out completely, the pale green crystals turn white - presumably due to loss of water of crystallization. I don't know the chemical composition of the outer layer of white needles - it may be simply a different crystal form, or a different hydrate, or perhaps a different oxidation state.

Once the pebbles have become active, a fresh layer of copperas will appear within two or three days of removing the original crust - you don't have to wait weeks as I had to do at the start. It is important that the nodules are left poking out of the rain water into the air. Exposure to daylight doesn't seem to matter, but rain water seems to be preferable to tap water.

I haven't tried to get oil of vitriol from my crystals yet, but I have used them to make black ink. Simply add a solution to cold tea - and Hey, Presto ! The dense black can be rendered colourless by adding oxalic acid to the liquid. The black solution was the only black dye permitted by law for dyeing silk in Britain for several centuries. It was the only black ink used from ancient times which was not based on soot. Cold tea contains tannin - as does an extract of oak or other barks, oak galls, pomegranates and many other vegetable sources. Tannin produces a black pigment with iron. Try hammering a nail partly into a piece of oak and leave out in the rain for several weeks. You will get a black streak, not a rusty one as you would expect.

Roasting the copperas will leave a rusty residue of iron oxides, known as Jeweller's Rouge or Venetian Red, depending on the hue and the method of preparation. This can be used for polishing glass and gold, or as a pigment.

Roasting the copperas with potassium nitrate should yield brown fumes of nitric acid.

Vitriol is also used in the collodion photographic developing process

Antimony

tionary, as well as with a method of making "regulus per se," but seems to have thought the star only appeared with the use of the iron. Here are his dictionary entries on the subject.

Regulus of Antimony is made of Antimony Salt Peeter & Tartar ana: put by spoonfulls into a red hot crucible & fluxt when all is in. When tis cold in the crucible you will find a black Sulphur on ye top layd hold on by fixed Salts, & a metalline body below like lead but brittle wch is ye Regulus & of this they make ye Antimoniall Cups.

Regulus Martis is made by casting two pts of Antimony upon one of Jron heated white hot in a Crucible & melting them ↗ well ↙ together wth a little Saltpeeter to promote the fusion. When tis cold ye Regulus will bee in the bottom; which being againe 3 or 4 times melted wth Salt Peeter is thereby purifyed & when cold hath an upper surface (under ye Saltpeter wch is then of a cleer Amber colour) wth stellar figures & is called

Regulus martis Stellatus[40]

No alchemical implications at all appear in Newton's dictionary en-

Liquation Process

This is a method for purifying and concentrating stibnite ores which contain 50% or more antimony sulfide. Lower grade ores are purified by different processes, one of which we will look at later.

The crushed ore is placed into special crucibles that have an opening at the bottom connected to a tube that runs out of the furnace, or to a cooler region at the bottom of the furnace. The furnace is heated using gas, coal, or even wood. As the crucible of ore heats up, the stibnite melts and flows out of the tube at the bottom into a catch vessel. Sometimes the catch vessel is filled with water so that as the molten stibnite hits the water, it cools and is shattered into finer particles. This makes grinding it later much easier. The residue of the ore remaining in the crucible consists mainly of the matrix rock, such as silica, which contained the stibnite, along with some of the stibnite that didn't melt out. It is saved for processing as a low grade ore.

The material that did melt out is often well over 95% pure antimony trisulfide and suitable for use in alchemical works; it forms especially nice glass and regulus.

We can use simple materials to perform this type of concentration easily.

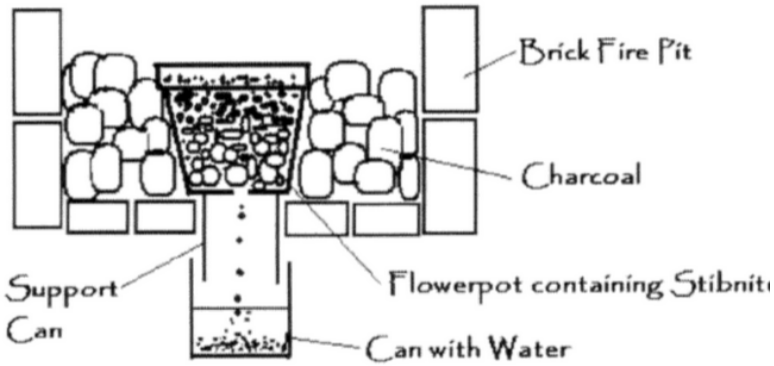
For the crucible, an unglazed earthenware flowerpot with a hole at the bottom works well. You can find these at any garden supply in a range of sizes to fit your needs.

Use firebricks to construct a simple fire pit with a supporting metal can, having both ends cut out, placed in the center. Three or four nails poked in through the side of the can will hold it in place an inch or two from the furnace bottom. Below this can is placed a second larger can, such as a coffee can partly filled with water, to act as a catch vessel.

Fill the flowerpot with crushed stibnite, placing larger fragments at the bottom and finer portions at the top. You can cover the pot with a piece of steel screen to keep ashes out and also keep heat in. Heating is provided with charcoal packed all around the flowerpot as shown in the diagram below.

Collect all of the material that falls into the catch vessel as your purified stibnite, and be sure to save the residue remaining in the flowerpot, as it can be processed further by the Kermes method described below. Also, save the water from the catch vessel, as it can be used for preparing Vinegar of Antimony.

vessel, as it can be used for preparing Vinegar of Antimony.



Liquation of Stibnite

Kermes Mineral

Stibnite is easily soluble in strong alkaline solutions, forming alkali antimonates.

By taking advantage of this property it is possible to purify Stibnite, even low-grade ores, with a chemical process. The result of this purification is a red-brown powder called "Kermes Mineral", named after a dye of this color made from insects. Chemically it is known as Antimony Oxysulfide.

The preparation is easy but involves using a strong caustic solution and it produces a foul-smelling odor like rotten eggs (hydrogen sulfide), which is quite toxic to breathe, so this is best performed outside or in a fume hood.

Start by grinding the ore or the residue from the liquation process to a fine powder, then set it aside until we need it.

Now prepare a strong alkali solution by dissolving Lye (sodium hydroxide) into

rainwater. A 20 to 30% solution works well; this will get very hot as the lye dissolves, so add it slowly to avoid boiling; also wear eye and hand protection. You can find lye

Mark House - Newton And Flamel On Star Regulus Of Antimony And Iron

Newton And Flamel On Star Regulus Of Antimony And Iron...Part 1

Gale E. Christianson[1] in his scholarly book subtitled "Isaac Newton & His Times," in chapter 9 entitled: The Treasures of Darkness, presents excerpts from Newton's alchemical writings.

Principally, the quotations are from the early to late 1670s, focussing specifically on making regulus of iron and antimony to further produce a philosophic double mercury that was animated by several distillations and subsequently caused swelling and putrefaction in gold.

Nicolas Flamel, in his Breviary, a division of his book "Abraham the Jew," gives essentially a straightforward description of the same process for the Great Work.

This article will attempt to sort out in part, Newton's path, while also touching upon Robert Boyle's related experiments, and making some comparison to the Flamel Work.

Commentary on these two paths may be helpful to receive some details where they are missing in Newton's writings and in Christianson's additional notions, since some details seem to have their appearance in Flamel's study.

Here in this chapter on Newton's breakthrough experience, is evidenced interesting parallels that also prescribe much of LPN's up-to-date research to convey more fully the apparent omitted details. Included are Newton's proportions in the processes to obtain the Starry regulus of antimony and iron; Lunar Regulus, and Lunar Venusian Regulus.

By 1670 Newton's attention had focussed on the regulus of antimony, a substance that was to remain near the center of his thoughts for as long as he pursued the hermetic art.

We know antimony as a metallic element, a hard, extremely brittle, glistening, silver-white, crystalline material used in a wide variety of alloys.

Christianson here speaks as the chemists of our time do by using the term alloys to employ the use of antimony [sulfide] i.e. the ore Sb_2S_3.

It should however be noted that the iron must not be used in excess, therefore the regulus is not an alloy at any stage.

Christianson's next comments show that it's not the trisulfide we need, but the metal stibnite. LPN has shown that it's necessary to separate the free sulfur from the stibnite by heating the broken up antimony ore in a heat resistant tube where it's melted and dropped as small pellets into distilled water to obtain the desired material for regulus.

To the alchemists, however, antimony was not the metal itself but stibnite, the

lead-gray ore from which it was extracted by heating it with charcoal or some other mild reducing agent.

The metallic antimony sinks to the bottom, and this (our element) is what the alchemists called the regulus of antimony.

The last two paragraphs speak of a reducing agent [this should be done in a furnace in a crucible] saltpeter or potassium sodium nitrate acts as a fluxing agent and iron and eventually silver will act as the reducing agents. When the regulus is poured into the warmed mold the metal sinks down [you may tap on the mold with a hammer to help it sink down to the bottom while the scoria solidifies as it cools on top of the metal.] A button of metal is obtained this way, which must undergo further purifications to reach the star regulus.

The name probably derived from the Latin regulus, meaning petty king. Because the regulus of antimony combines readily with gold (the king of metals) it became important to the process of refining the precious metal and an object of considerable experimental interest to seventeenth-century adepts.

The regulus was also separated from stibnite by the introduction of various metallic reducing agents, in which case it became the regulus of Venus (copper), the regulus of Jupiter (tin), the regulus of Saturn (lead), or most importantly, the regulus of Mars (iron).

It was thought, quite erroneously, that the "seed" of the metal used to reduce the regulus from the ore remained embedded in the regulus itself, thus raising all sorts of tantalizing possibilities in Newton's mind.

The seed of course is in the scoria and also in minute quantity in the metals applied in the work. The seed is the sperm of the metals and Newton probably knew that he was to locate this seed and to cultivate it; sew it in the Duplex or animated, philosophic mercury.

The star regulus to which has been added silver; its ensuing purification to purple or violet color; additionally triple distilled Hg is incorporated, its then washed and ground, and washed again until it is a pure and shining mirror...the black particles that are washed away from the amalgam is kept for further research.

The earliest evidence of his interest in the different reguli had surfaced in the form of notes copied into the chemical dictionary between 1666 and 1667. [2] Now, some two years later, the young adept felt sufficiently emboldened to compose his own essay on their preparation. As usual, he wrote with the confidence born of firsthand experience:

Isaac Newton
"These rules in general should be observed. 1st if the fire be quick. 2nd if the crucible be thoroughly heated before anything be put in; 3rd if metals be put in successively according to their degree of fusibility [iron], copper, antimony [stibnite], tin, [lead]. 4thly That they stand some time after fusion before they be poured off accordingly to the quantity of regulus they yield [iron] to keep it from hardening. 6th That if you would have the saltpeter flow without too great a heat, you may quicken it by throwing in a little more saltpeter mixed with 1/8 or 1/16 of charcoal finely powdered."

Clearly Newton had prepared many reguli and had found the right proportions and timings; both by waiting to pour the regulus, and probably discovered the correct appearance of the ready matter and manipulated the technique at the right moment.

Newton went on to enumerate the many telltale "signes" of failure that, in their turn, had disturbed the rapt tranquility of his laboratory. But with the perfection of his experimental technique success was soon assured:

Isaac Newton
"Thus with a good quick & smart fire - 4 of [iron] to - 9 of [stibnite] gave a most black & filthy scoria & the Regulus after a purgation or two, starred very well." [3]

LPN has suggested several mixes of nitrate and tartrate, purified stibnite, and

iron nails. Newton directly refers to the black scoria [the crow] and 2 purgations (purifications) with the potassium nitrate (can take up to 3-4 purifications), that will obtain a 60 degree angled star. Note that unless you go over the star you will not have the right regulus for the work.

The term "starred' was here employed by Newton in its most literal sense. For if the antimony has been properly purified as in this instance, it forms long and slender crystals. During cooling the crystals in turn form triangular branches around a central point, taking on the aspect of a silver star.

Masters of the symbolic, the alchemists named this heart of antimony ore after Regulus, the bright double star near the heart of the constellation Leo. When the star regulus of antimony was achieved with the aid of a metallic reducing agent in the above experiment, Newton had produced the star regulus of Mars.

Further confirmation of his success is contained in a letter to Oldenburg of January 1672: "What the stellate Regulus of Mars (which I have sometimes used)...will do" as a reflecting mirror in a telescope "deserves particular examination. [4] Yet it was for profounder reasons than the fashioning of better telescope mirrors that Newton long remained concerned.

To obtain a very shining mirror-like surface Newton must have found just the right mixture, thus using silver he obtained the Lunar regulus. Newton and Flamel amalgamated this regulus with thrice distilled mercury. Once washed, it is a reflecting mirror.

At exactly what point and under what circumstances Newton began to contemplate seriously the principle of attraction between physical bodies is impossible to say. The general idea of gravity, though far from well developed, is certainly hinted at in the "Hypothesis of Light," the controversial paper he sent to the Royal Society in December 1675. It has been observed that the lines of crystals that appeared to radiate out from the center of the star regulus "might just as well be considered as radiating into the center, which gives them the character of attraction rather than the character of emission."

If, indeed, Newton viewed the star regulus in this light, then the very concept of gravitation "in which the lines of attraction run in to and converge in a center point" may have suggested itself to him. [5]

Present in this diminutive terrestrial orb was the invisible cosmic glue that binds the planets to the stars and the solar systems to the galaxies of the macrocosm. Most probably, however, the idea of gravitation had not taken such definite form in Newton's mind in the early 1670s, though there is no question that at its roots eventually found ready nourishment in the fertile field of his alchemical thought.

It's extremely interesting to note that gravity is compared to the central point of geometric crystallization. Newton must have recognized as Flamel did that through the numerous 7-9 eagles or distillations that the crystalline structure of the regulus amalgam was progressively adjusting and rising in a set pattern towards a cubic fundamental matrix. Above this pattern is the absolute or inter atomic energy which surpasses the atomic material energy. To distill the amalgam above 9 times generally leads to an explosion. The cubic structure is the most perfect of the crystals having perfect right angles and equilateral triangles in its arrangement. This matter is the seed risen to its highest purity.

Nor, if Newton's notes on Basil Valentine are accepted at face value, did he mistake the star regulus for the philosopher's stone, as had more than a few bedazzled adepts.[6] Instead, Newton looked upon the star as a most promising step in the creation of the philosophical mercury, the materia prima or first matter from which all substances are formed.

Robert Boyle obviously experimented much with the reguli, including the regulus of antimony and iron.

Excerpt from text on British Royal Society:
Robert Boyle, in his book "On Unsuccessfulness of Experiments"[7] says: "And it may perhaps also be from some diversity either in antimonies or irons, that eminent scientists (chemists) have (as we have observed) often failed in their endeavors to make the starry regulus of Mars and Antimony.

In so much that diverse artists fondly believe and teach (what our experience will not permit us to allow) that there is a certain respect to times and constellations requisite to the producing of this (I confess admirable) body."

On a clear, uncloudy, and windless day, the regulus will become starred quite easily when you're ready, and sufficiently skilled in the process. The clear weather helps considerably, but then so does the bond between the matters and the operator.

In the mid-1670s, Newton composed a paper of some 1,200 words entitled "Clavis" ("The Key"). This intriguing document, so concise and polished, gives evidence of being the last in a succession of drafts, the compilation of which had by then become one of Newton's distinctive intellectual trademarks.

The contents represent the distillate of years already spent in the meticulous study of the star reguli in the hope of extracting philosophical mercury from common metals. It was clearly Newton's belief that he had succeeded in doing just that.

It was not extracting philosophic mercury from common metals that Isaac Newton was after, but THE Philosophic Mercury or amalgam that would make the little trees of tiny crystalline branches grow, the sophic gold, so that he could bathe his gold in it, to multiply it, and animate it, for its magical properties.

Newton began with the star regulus of Mars (Iron) which was fused with a small quantity of pure silver, the "Doves of Diana." To this he added common mercury, amalgamating the mixture in a sealed vessel over a "slow fire." The amalgam was then ground for "1/8 of an hour in a mortar...until it spits out its blackness."

Repeated flushings, grindings, and washings left an alloy "like shining and cuppellated silver." A series of seven to nine more distillations and washings produced a mercury seemingly capable of dissolving all metals, especially intractable gold. The cauda pavonis, the multicolored tail of the peacock described by ancient alchemists, unfolded before Newton's very eyes:

Note that Nicolas Flamel experienced the same things while manipulating the amalgam, the gold, and the silver. Below Newton writes:

Isaac Newton
"I know whereof I write, for I have in the fire manifold glasses with gold and this mercury. They grow in these glasses in the form of a tree, and by a continued circulation the trees are dissolved again with the work into a new mercury. I have such a vessel in the fire with gold thus dissolved, but extrinsically and intrinsically into a mercury as living and mobile as any mercury found in the world. For it makes gold begin to swell, to be swollen, and to putrefy, and to spring forth into sprouts and branches, changing colors daily, the appearances of which fascinate me every day. I reckon this is a great secret in Alchemy."

The Philosophers Of Nature excerpt from Guelph, Ontario, Canada, 1992.

Martial Regulus is not good enough...

We can make an amalgam of [Star] Regulus and silver which equals the Lunar Regulus, or a [Star] Regulus of silver and copper which = the Lunar Venusian Regulus. When this last amalgam Lunar Venusian Regulus is well prepared it is a light purple color.

Make a fine powder from this Lunar, or Lunar Venusian Regulus, add triple distilled Mercury (i.e. distilled Hg, caution must be exercised when handling Hg, even when cold its vapors are very toxic), and place the fine powder with the triple distilled {Hg} mercury into a tumbler to mix together thoroughly.

When you stop the tumbler, (leave on for 12 hours) you will have a butter [e.g. a buttery-like amalgam]. Note: Remove the butter from the tumbler with (surgical) rubber gloves and wear goggles (caution - this butter is very corrosive), clean the tumbler with distilled water right away otherwise it hardens in an hour. The water turns black and a black powder forms. Wash the amalgam thoroughly, persist until it is mirror-like. Set this water and black powder aside in dark vessels.

There are three products which can be obtained from these amalgams i.e. sophic mercury, live mercury, and animated mercury.

Distill this amalgam (butter). This [according to Flamel's Breviary] is known as the Philosophical Sublimations and the Chores of Hercules, or the Flying of the Seven Eagles, the result will be an Animated Mercury.

The double mercury or duplex [animated mercury] is then seeded {this is known as Sowing to obtain the Elixir.} (note: seeding can be done with the seed contained in the scoria of the first fusion or with live mercury, with animated cinnabar, with native gold, the black powder, or live sulfur) and placed into an incubator.

Obtaining the Elixir is when the colors come; black; white; orange; red.

At this high stage of the work Multiplication becomes a next step using the red stone in the same fire and same vessel and animated mercury.
Then comes the Revolutions of the Wheel where the power of the red stone increases by powers of ten. Even leading to an eternal lamp diffusing an eternal light...

CARES TO BE TAKEN FOR THE AMALGAM

1. Proportions: The triple distilled mercury Hg weight will be from 3 to 5 times the Lunar Venusian Regulus weight, generally.

2. Proportions are not crucial, as the animation occurs during the successive eagles. At each eagle (distillation) the mercury animates by taking the metallic life from antimony through silver (the medium silver is a transfer metal, the transfer occurs when the metals are melted). Absorption of the energy is more important in the first eagles than in the latter. In an eagle the life of the regulus weakens silver this is called the Dead Doves of Diana, and this same silver can be used indefinitely for more amalgams. An eagle means: amalgam with mercury Hg, and regulus and distillation of the amalgam.

The dissolution of gold, not its multiplication, is what most interested Isaac Newton. He measured the magnitude of his supposed achievement against Boyle's oft-repeated alchemical dictum: "It is easier to make gold than to destroy it." In other words, once someone has solved the knotty riddle of what a substance is made of, producing that substance should be comparatively easy, a familiar enough notion to the student of modern chemistry.[8]

Newton's pursuit of the true philosophical mercury had caused him to draw heavily upon the works of George Starkey, who, as previously noted published under the pseudonym Eireanaeus Philalethes. Nine of Starkey's books graced the shelves of Newton's library when he died, a number matched only by the indispensable treatises of Count Michael Maier.[9] The mediation of special mercuries were set forth in a manner strikingly similar to those expressed by Newton in the "Clavis" manuscript.[10] Moreover, Starkey sought to put this knowledge to a practical use by effecting the process of transmutation.

Philalethes (see An Open Entrance to the Closed Palace of the King) gives the process for making regulus and amalgam that Newton and Flamel do. It being so similar that without doubt Newton knew that Starkey was an adept in the work, and after reading an article published by Oldenburg, and written by Robert Boyle in the Philosophical Transactions of the Royal Society entitled "Of the Incalescence of Quicksilver with Gold, generously supplied by B.R.":

Newton, who did not get around to reading his issue of the transactions until April 1676, had no trouble identifying the author as Robert Boyle. Boyle wrote of having discovered a special mercury that grows hot (incalescent) when mixed with gold. He considered it a breakthrough in the preparation of medicines, but he was also wary of the great harm its disclosure might do. For if Boyle had refined a true philosophical mercury, a discovery Newton privately claimed as his own, it could be used by "ill hands" to multiply gold, thus lifting the lid from a Pandora's box of endless "political inconveniences."

Boyle sought advice from the "wise and skilful" as to whether he should make known to the world the specific ingredients of his recipe for the mercury.[11]

Newton, it seems was the only adept who chose to reply, at least in writing [to Oldenburg]. He cautioned Oldenburg to "keep this letter private to your self."

His usual desire for secrecy was underscored by the knowledge that the attempted transmutation of metals was legally punishable by hanging. As an alchemist, Newton could not but question Boyle's optimistic conclusion regarding the mercury. He had explored methods similar to Boyle's, only to abandon them for more encouraging prospects. Still, Newton counseled caution, partly perhaps to avoid alienating a respected colleague, and partly because Boyle might know more than he had let on:

Isaac Newton to Oldenburg
"It may possibly be an inlet to something more noble, not to be communicated without immense damage to the world if there should be any verity in the Hermetic writers, therefore I question not but that the great wisdom of the noble Author will sway him to high silence till he shall be resolved of what consequence the thing may be either by his own experience, or the judgment of some other...that is of a true Hermetic Philosopher... there being other things beside the transmutation of metals (if those great pretenders bragg not) which none but they understand." End of quote.

While Newton doubtless shared Boyle's concern for the dire economic and social consequences that must follow from an easy transmutation, one senses that this cautionary advice was rooted in other than altruistic grounds.

No common "goldmaker," Newton's personal anxiety surfaced when he employed the self-revealing phrase "there being other things beside transmutation of metals." If Boyle were to disclose this great secret of the ancients, Newton's belief in his special relationship with the Almighty must suffer irreparable harm. The gates of the prisca sapientia would have been breached, and to the vulgar materialists would belong the desecrated spoils.

Flamel and Newton, like all true adepts of alchemy revered the Most High and Divine Will of God. Boyle may too have held a faith denying the philosophy of the times that Descartes put forth, "separating body from spirit in nature, to deny, as it were, that any "occult" forces, such as attraction and repulsion, are manifest in this great chain of creation. Though a mechanist tried and true, Newton could never be persuaded that spirit was absent from the operations of nature."

As a member of the inner circle that directed the general course of Royal Society activities, Boyle was surely aware of Newton's reticence in scientific correspondence. Yet it seems doubtful that Boyle was taken aback when Oldenburg informed him of the Lucasian Professor's response to his recent paper.

Indeed, he had good reason to think that his newfound friend might have written even more.

Boyle, after all, was the seventeenth century's most astute practitioner of "chymistry," and he had been present some months earlier during the reading of Newton's much-debated "Hypothesis of Light." Interpreted by most as the treatise on mechanical philosophy Newton meant it to be, the paper's equally profound if veiled alchemical implications could hardly have escaped Boyle, especially considering that Newton accepted and elaborated on a number of his ideas.

The study of alchemy for spiritual quickening lost its romance and adventure in the 17th century, particularly for the vogue chemists that would turn away from the past to embrace an unknown but promising future of enterprise and commerce.

Robert Boyle and Isaac Newton were two individuals important to the art in a century replete with nascent discovery. This renaissance period of practicality, inspired men of conscience to the design of the Royal Society's objectives:

"The business and design of the Royal Society," as Robert Hooke wrote, is "to attempt the recovery of such allowable arts and inventions as are lost," and "to examine all systems, theories, principles, hypotheses, elements, histories, and experiments of things natural, mathematical and mechanical, invented, recorded, or practiced by any considerable authors ancient or modern." Nor will the Society "own any hypothesis" until "by mature debate and clear arguments, chiefly such

as are deduced from legitimate experiments, the truth of such experiments be demonstrated invincibly."

1. Free Press, 1984 In the Presence of the Creator.
2. MS. Don. b. 15, ff. 4v-5r
3. U.L.C. ADD. ms. 3975, p. 82.
4. I.N. Corres., I:82.
5. B.J.T.D., p. 150.
6. Keynes MS. 64, f. 4r.
7. Opera, ed. 1772 i, 325.
8. B.J.T.D., p. 185.
9. J.R.H., pp. 65, 215, 243
10. One student of Newton's alchemy has argued that he probably copied "Clavis" from a lost manuscript of Starkey. Karen Figala, "Newton as Alchemist," History of Science, XV (1977): 107. For an opposite view, see Richard S. Westfall, "The Role of Alchemy in Newton's Career," p. 207, and B.J.T.D., pp. 175-78.
11. Philosophical Transactions, X (1675-76): 515-33.

The Matters of the Great Alchemical Work

Throughout the passing of time, a lot has been written about the matters used in the Great Work. In accordance with what we have read in the great works of classical and contemporary Masters in each of the alchemical ways, a different and specific matter is used.

There are artists that affirm that the matter of the Great Work is one and universal without specifying what the matter is, nor do they give us the least of indications that would permit the investigators of the Art to recognize this matter. For that reason, we find these statements cloudy.

The reading of the alchemical texts of the great Masters written in symbolic language allows for diverse types of interpretations according with one's knowledge. Unfortunately, in many cases, not always corresponding to what the Masters wanted to express in their writings. On the contrary, some very well known alchemical books from time to time were written in a clear language. It is only ignorance of the most elementary principles that governed the different alchemical operations written about at the time that allowed one to make such rude errors of interpretation.

Those who read that interpretation without the necessary knowledge in order to evaluate it, such as beginners who are in their first steps in the study of the alchemy, unavoidably keep misunderstanding the idea of what the matters are that are used in the different alchemical works as well as of the Modus operandi.

Not only do we refer to the matters, which are a very important part in an alchemical work, but also to the related ways of most well known alchemists.

We are not in the XVII or XVIII centuries when writing books on alchemy was in fashion, and when the authors were hidden under a motto that few knew. Example of this is the vast amount of attractive books written at that time. Their content is lacking of teachings, being for that reason money spent out.

Nowadays, to write a book on alchemy under a well-known motto, imply responsibility by the author, because a reader can compare with original works and easily perceive any inaccuracies. However the beginner in the study of the Art will not much hesitate to believe what they read because they trust that one who writes a book on alchemy knows precisely what he is speaking of.

However this is not always so, for at times we find in the writings of certain modern authors, texts lacking in their essence and doubtful descriptions without basing them on the original texts.

Following this short introduction we are going to point out which are the main alchemical ways practiced by our classical and contemporary Masters as well as the matters employed in them.

Dry way. The matter of the dry way is, par excellence, the antimony or stibnite. The old alchemists in order to distinguish the mineral from the metallic antimony called the latter regulus. For that reason, when we talk about the antimony we want to designate their mineral, that is to say, the stibnite.

Some artists affirm that the dry way is done from the glass of antimony. We are not of the same opinion because this statement doesn't have consistency and only those who don't know the magisterial work of Basil Valentine, "*Le Char Triomphal de l'Antimoine*", Retz, Paris, 1977, will make such statement.

The glass of antimony whose preparation is minutely described in the page 163 of this book, besides being used to make the stone of fire, is used also for the preparation of the tincture of antimony. The preparation of the stone of fire has nothing in relation, neither comes close to, with the dry way of the antimony and it is hardly considered as being the "matter".

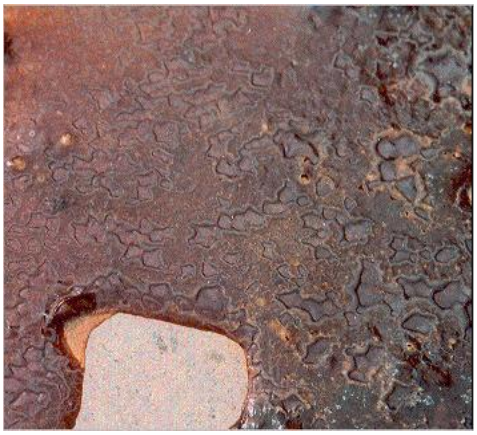
Let's see the cause of our disagreement. From the glass of this mineral, the mercury of the antimony is not extracted because the mercury of this mineral is the martial starry regulus highly purified.

The preparation of the glass of antimony is not so simple as to place the antimony powdered in a hearth, fuse it and so convert it in glass.

The preparation of the glass of antimony requires much experience and one will not arrive at a canonical glass if one isn't observing and practicing. And, so that you are not left to hesitation as to how much is our disagreement we are going to describe its canonical preparation.

In first place, grind the stibnite powdered very fine and pass it through a sieve of 60 lines for centimeter. The very fine powdered mineral is calcined with very strong fire in an iron recipient or clay refractory in order to extract from it all the chemical sulphur. Only after this operation is the oxide fused in a hearth with the respective cover, in a gas oven with very strong fire.

After it is well liquefied it is poured over a copper sheet or over a marble stone. If the glass was well prepared, and this operation is not within everyone’s reach, we will have a red colour very alive looking and transparent in front of a very strong light like the solar light. We have already prepared kilograms of this glass of antimony, for this reason we are able to describe with total knowledge their preparation.



Glass of antimony.

The glass of antimony is soluble in spirit of vinegar with which one could extract their tincture.

For that reason it is not the matter of the dry way but this is the matter for the preparation of the stone of fire with which, on the contrary of what some artists affirm, one could make some transmutations as the Master says in the page 237 of the same book:

«Considering the proposed point that with the antimony, the stone of fire could be prepared, and it is said that this healthy stone cures some particular infections not only in man but as well in metals.»

And in the page 238:

«The tincture of this stone of fire is not universal like that of the philosophers, which is prepared of the essence of the sun, and is still less universal as to all the other stones.»

And in order to conclude in the page 249:

«In a word, this stone, as a particular tincture, transmutes all the metals into very pure gold and better than that of the mines of the Peru. It is a medicine for all the illnesses which man could suffer.»

In short, the stone of fire, is a transmuting "stone" resulting from a "particular" made through the dry and humid path, and is not the dry way of the antimony.

For that reason, where it is said that the dry way from the antimony is done with their glass, alchemically it doesn't have any consistency, by which they who don't know the Art will be compelled to complete error.

The dry way properly said is done it with the stibnite as it is described in all detail by Eugene Canseliet in his "*L'Alchimie Expliquee Sur Ses Textes Classiques*", Jean-Jacques Pauvert, Paris, 1972.

But then, who was Eugène Canseliet? Canseliet was Fulcanelli´s disciple. Fulcanelli was the nom de plume of the painter Jean-Julien Champagne.

Jean-Julien Champagne

"*The Dwellings of the Philosophers*" was written by Jean-Julien Champagne with elements taken from Pierre Dujols'files who was a bookseller. He was a big alchemist and had a disciple that worked with him in the laboratory.

Pierre Dujols was an erudite and the author of the first ever comments to the "*Hypotypose*" (a comment of "*Mutus Liber*") under the Magophon nom de plume.

Eugène Canseliet published the book "*Les Demeures Philosophales*" as a disciple of Fulcanelli. If Canseliet followed the dry way of the antimony and was at the same time a Fulcanelli's disciple to whom he would work then his Master's path was obviously also a dry way. "*Fulcanelli devoilè*" Genevière Dubois, Editions Dervy, Paris, 1992.

Concerning this way, in "*The Dwellings of the Philosophers*", the authors (Champagne and Dujols) describe other ways of such an amalgam, that are almost impossible to distinguish when they refer to the dry way or to the wet way. This has resulted because the descriptions given do not have a sequence. Even an expert artist will have difficulty in making the distinction.

There are artists that say that Fulcanelli doesn't refer to the dry way from the antimony and that he neither describes it.

Let's see, then, the detailed description that Fulcanelli makes of the mineral related to the dry way in "*The Dwellings of the Philosophers*", Square & Janes, Corp. editors, 1973:

« All ores, through the hermetic voice, rendered homage to it with their name. It is also called Black Dragon, covered with scales, venomous serpent, daughter of Saturn and the most beloved of its children. This primal substance has seen its evolution interrupted by the interposition and penetration of filthy combustible sulphur, which coats its pure mercury, holds it back, and coagulates it. And, though it is entirely volatile, this primitive mercury, materialized by the drying action of the arsenical sulphur, takes the shape of a solid, black dense, fibrous, brittle, crushable mass rendered, by its lack of utility, vile, abject, and despicable in the eyes of man. Yet in this subject - poor relative of the metal family - the enlightened artist finds everything that he needs to begin and perfect his Great Work.»

«For this reason they symbolically depicted their matter in its first being as the image of the world that contained in itself the materials of our hermetic globe, or microcosm, assembled without order, without form, without rhythm or measure.»

Let us see, then, the meaning of this description:

«All ores, through the hermetic voice, rendered homage to it with their name.»

Those who know well "*Le Char Triomphal de L'Antimoine*" of Basil Valentine, will remember the picture on page 64 Frontispiece du "Char Triomphal de L'Antimoine", where the alchemical planets (metals or minerals) symbolically represented, Saturn, Mars, Venus, Mercury and the Moon, pull a wagon lead by Vulcan. This wagon is used to carry the antimony, pictured by a lady that bears on her womb the antimony's spagyrical symbol, i.e., a *cruciferous globe*, thus paying it and homage.

«It is also called Black Dragon, covered with scales, venomous serpent, daughter of Saturn»

Some of the names by which antimony is known are Black Dragon, Grey Wolf, and most commonly offspring of Saturn.

In the "*Tabla Redonda de los Alquimistas*" by Manuel Algora Corbi, Luiz Carcamo, editor, Madrid, 1980, "*La Medula de La Alquimia*", Eirenaeus Philalethes, page 307, one could read:

«The substance that we took first is a mineral, familiar to the mercury, that cooks a raw sulphur in the earth; vile visible, but glorious inwardly, the son of Saturn. What more do you need? Conceive it correctly because this is our first matter.»

«It is colour of sable, with silver veins that appears mingled in the body, whose sparkling shade stains the connate sulphur. It is completely volatile and nothing fixed, but taken in their native crudeness purges all superfluity of the sun.»

The Fulcanelli attributed characteristics to the antimony are confirmed in this text.

Black dragon

Our mineral, being son of Saturn, has characteristics very similar to those of its ancestor. It is colour of sable (sable in heraldry, corresponds to the black) with silver veins and their shine is stained connate sulphur. It is all volatile and purges every superfluity of the Sun. It is fibrous, brittle, and at that time was of little utility beyond its medicinal use.

This means in current language that it is a mineral of black colour with silver veins, volatile, friable, whose shine is stained chemical connate for sulphur and that purges all the superfluities from the Sun or gold.

These physiochemical characteristics correspond to those of antimony that is, as we know, a sulphide. It was with the antimony, that the old alchemists purified the Sun or gold as one can see in the First Key of Basil Valentine.

«For this reason they symbolically depicted their matter in its first being as the image of the world that contained in itself the materials of our hermetic globe»

In the First Image of the book "Speculum Veritatis", which means in English "*Mirror of the Truth*", Philalethes describes symbolically the First Work of his way, that is, the preparation of the martial starry regulus that we explained in detail in our website at Terravista, Planeta (with links to the matters) and in our book "*La Gran Obra Alquímica*", Mirach Editorial, S.L., Villaviciosa de Odón, Madrid, 1999, page 15. You will see there a lame man with a tick leg representing Vulcan, giving to two old men (alchemists) a **cruciferous globe** that is the spagyrical symbol for antimony like any expert alchemist knows. But like this globe has a star in its center, it represents, for that reason, the **martial starry regulus**.

If any analogy exists with the word "mirror", cut or break the martial starry regulus traversely after the mercurial purification's and you will verify that it crystallizes in similar layers like those of the mica, as brilliant as the more refined silver and like a mirror. For that reason many artists call it "mirror of the Art".

But we won't limit ourselves hardly to these texts in order to demonstrate to you that Fulcanelli describes unmistakably the antimony.

In the "*Oeuvres*" book- Nicholas Flamel, Courier Livre du, Paris, 1989, page 196, says:

«Try, in the first place, to take the **first-born** of Saturn that has nothing to do with the vulgar, nine parts, of the sable of steel of the warrior God, 4 parts.»

Philalethes in the "*Open Entrance to the Closed Palace of the King*", section XI, "Of the Invention of the Perfect Magistery", nr. VII, says:

«Afterwards, they were interested in an **offspring of Saturn**, and they tested its action over gold; it having the power to free the gold from its impurities...»

Flamel is talking about the antimony that, together with the warrior god Mars and the suitable salts will make the martial regulus, required to begin his work as in the Philalethes' amalgam path.

What is Fulcanelli talking about anyway? From what we've described, you'll be able to see that the Master talks about the **antimony**.

The preparation of the antimony regulus is not as simple as melting it with a proper heat and moulding it, as some artist's claim.

This, alchemically speaking, would be as claiming that a car is built with four wheels and little else!

Statements like these denote a lack of knowledge of the writings of the XVII century, as the "*Traité de la Chymie*", Christophle Glaser, Paris, 1663, page 174, where the preparation of the antimony's martial regulus is described in detail. Also Lemery, in his "*Cours de Chymie*", Paris, MDCCLVI, on page 272, describes the same operation!

The starry martial regulus is not made simply after the fusion of antimony and moulding on a stainless steel mould.

In order to make a good canonical martial regulus one needs a suitable gas oven, where one can reach a temperature near 1000º centigrade, a good mineral ore and his metallic acolyte Mars, as also the indispensable melting salts. These and the "hand work" required that only an expert artist has, are the requirements to proceed with the work.

The first preparatory operation of the dry path is called *Assation*. It is ignored by most and is only done when preparing a canonical work. Next comes the *Purge*, which consists in the purification of the mineral of its siliceous refuse in a refractory clay crucible, in the aforesaid oven. Then follows the *Separation* which, as its name explains, consists in separating the regulus from the antimony by use of its acolyte Mars and the suitable salts. When the metal reaches a proper temperature and is melted, it is poured into a stainless steel conic mould. After slowly cooling, the Caput is separated according to Art. From this Caput the philosophical sulphur will be extracted.

Then follows the *Mercurial Purification's* in order to purify the regulus with the suitable salts until the star shows up, and also to extract the vitriol or Green lion. We then proceed to the *Eagles*, i.e., and the sublimation of the alchemical sulphur and mercury that will have as result the *Remora*. Finally, the latter will be cooked with the respective salt or secret fire and as a result of this operation we will at last have the *Philosophical Stone*. It was at this point that Canseliet failed, due to the poor "external" conditions.

Martial regulus

This path takes more than just a few days to accomplish. Only a greatly expert alchemist will succeed, at least until the Eagles, corresponding to the Second Work. We have gone this far ourselves, so we may speak based on personal experience.

This is the time when the Artist needs the knowledge to make use of the cosmic radiation depicted on the fourth tablet of the Mutus Liber, as well of the polarized light emissions from the moon since its first quarter until the full moon.

The Amalgam path. This was the path followed by Philalethes and Flamel. One can find its description both on "*An Open Entrance to the Closed Palace of the King*" by Philalethes, as well as on Flamel's "*Brevière*"or "*Testament*".

A summary of Philalethes' path can be found on "*Concerning the Discovery of the Perfect Magistery*", chapter XI, which I highly recommend you to read attentively.

On nr. X, XI and XII is said:

«…The heavens were indeed temporarily clouded over, but after a copious downpour of rain, serenity was restored.»

«Mercury emerged in a hermaphroditic state. Then they placed it in the fire; in a short time they succeeded in coagulating it, and in its coagulation they found the Sun and the Moon in a most pure state.»

«...And when they placed gold therein, the fixed was volatilized, the hard softened, the coagulated dissolved, to the amazement of Nature herself.»

In our opinion, this excerpt describes Philalethes' other path which is a wet path, nevertheless requiring the martial regulus in order to prepare the philosophical mercury.

This mercury, when cooked in a closed vessel *per se* becomes Sun or Moon, i.e., philosophical Sulphur that by adding up of new mercury will enable you to proceed with your work.

But instead of cooking the mercury *per se* in order to transform it in sulphur, one can add to it metallic gold and continue the work as explained by the Master.

This is our understanding of Philalethes' nr. X-XIII.

On "*The Marrow of Alchemy*", the Master allegorically describes the preparation of the philosophical mercury and the way to his complete path. It is also described on a little treatise called "*Experiments*".

The preparation of this philosophical mercury is done through the amalgamation of the martial regulus turned into Solar or Lunar regulus by melting it with one of these noble metals. Only this way one will be able to amalgamate it with the common mercury. This amalgam is then distilled on a steel retort up to seven times. Philalethes calls each one of these distillations an "Eagle". One should take care as not to confuse these with the ones described in our other text titled "The Eagles".

This little treatise called "*Experiments*" can be found in the aforesaid book "*La Tabla Redonda de Los Alquimistas*", page 299, as well as in our Website at Terravista, in a portuguese translation.

We have a facsimile of these two little treatises written in ancient English that serve as a complement to Philalethes' main book "*An Open Entrance to the Closed Palace of the King*". These are a precious aid in order to understand the Master's work. In our Website at Terravista you will find a portuguese translation of the original of the aforesaid treatise "*Experiments*" as well as a text about Philalethes' work.

The Albertus Magnus' Work "*El Compuesto de los Compuestos*" (*The Composite of Composites*), described in the book "*Siete Textos de Alquimia*", anonymous author, Editorial Kier, Buenos Aires, 1978, pages 18-45 as also as in "*Le Composé des Composés*", Arché, Milano, has a different beginning despite being also an amalgam path. It starts with the sublimation of Mercury as you can also see in our website Terravista, under the texts titled "Mercury Sublimation", "The Eagles", "Our Gold" and "*O Composto dos Compostos*". It has been translated into portuguese.

Wet Path. The wet path, considered by the Masters as being the noblest of them all, employs as first matter the **cinnabar** and the **vitriol**. The majority of the wet paths are usually lengthy in time, but Kamala Jnana's way, as incredible it might seem, takes only 28 days.

Red Dragon

These two paths are completely distinct. The cinnabar path is described with great detail in the book "*Dictionaire de Philosophie Alchimique*", Kamala Jnana, Éditions G. Charlet, Argentiére (H.S) France, 1961. In our Websites at Terravista and Geocities, you can find some writings on this path with links to the actual matters, not only the first matter but the secret fire as well.

Because of this, some artists have accused us of being excessively charitable, due to the uniqueness of a clear representation of these matters on the international network and in many languages. We do not agree. Kamala Jnana's path will at first sight seem extremely simple but isn't so. In practice, we have found unsurpassable difficulties, despite our lengthy experience in Alchemy. Not only us, but also other expert artists have found the same difficulties. We will continue without weakening to strive with our brothers for the resolution of this problem.

Another wet path commonly known is the **Vitriol Path**. This is described in Basil Valentine's "*Le Dernier Testament*" Retz, Paris, Troisème Livre.

Natural Vitriol

In our book "*A Grande Obra Alquímica*" we describe this path with great detail. But as not to leave any doubt let us now quote some passages from the Master's text, on page 234, referring to the matter:

«Now, you must know that such soul or golden sulphur, like salt and spirit, is found stronger and most virtuous in Mars and Venus, and in Vitriol as well, as also Mars and Venus by retrogressions can be taken back to a most virtuous and effective vitriol. On such a metallic vitriol one finds all the three principles under heaven, which are mercury, sulphur and salt, and each one of them can be particularly extracted with little work and time, as you will see when I proceed to narrate a short story of a mineral vitriol, beautiful and of a high degree, that can be found in Hungary.»

And on page 238:

«When you have found such a high grade mineral that is clean and pure, called vitriol, pray then to God to give you intelligence and wisdom to proceed with your work. And after its calcination, put it in a strong closed retort. Have it distilled, firstly under a moderate fire and then a strong one. Have the white spirit

distil like snow that comes in the form of a terrible exhalation or wind, until it comes no more and every thing has been spit out. Observe that in this wind or white spirit all the three principles are contained... And because of this there is no need at all to look for these principles in the precious things.»

At the end of the Troisème Livre, on page 262, Basil Valentine, when talking to the blowers, says: «Oh, eternal God! What do these people think, being so much blind and foolish? Ah! It's an easy task, even for a child. One thing springs from another, as one can easily cook good bread from good wheat. But the world is blind and it will remain so until the end of times. Being so, I refrain from writing any further and commend you to the Sovereign.»

Rubellus Petrinus

Key to metals and chemicals

The 7 metals

Acids

- aqua fortis = nitric acid
- oyl of vitriol = sulphuric acid
- spirit of salt = hydrochloric acid
- aqua regia = nitric and hydrochloric

Chemistry

- Saltpeter/salpetre = potassium nitrate
- Sal ammoniac = Ammonium chlroide

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