MAR 20040017: BAD HEART SANDSTONE

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Alberta Mineral Assessment Reporting System

Alberta

A REPORT AND BACKGROUND INFORMATION

PERTINENT TO THE EXPLORATION

AND ANALYSIS OF

THE BAD HEART SANDSTONE ON

PERMITS 9396110003 AND 9396110004

October 22, 2004

Ronald T. Owens

October 22, 2004

Ronald T. Owens
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Alberta Energy
Mineral Operations Division
Mineral Tenure Branch
9th Floor, 9945 - 108 St.
Edmonton, AB T5K 2G6

Attention: Hazel Hensen, Agreement Administrator

I hereby submit an Assessment Work Report to cover the required expenditures for the following lands:

    All of section 21-6-09-079
    All of section 22-6-09-079
    All of section 26-6-09-079
    All of section 27-6-09-079
    All of section 34-6-09-079
    All of section 35-6-09-079   A total of 3840 acres or 1554.048 hectares

    All of section   2-6-09-080
    All of section   3-6-09-080
    All of section   7-6-09-080
    All of section   8-6-09-080
    All of section   9-6-09-080
    All of section 10-6-09-080
    The South-west quarter of section 11-6-09-080
    The South one-half of section 16-6-09-080
    The South one-half of section 17-6-09-080
    The South one-half of section 18-6-09-080   A total of 4960 acres or 2007.312 hectares

I have concentrated efforts on developing a leaching protocol for iron rich ore and comparing the results with a fusion protocol; however, getting a consistent correlation still requires more time and effort.

Respectfully yours,

Ronald T. Owens

Authorization to Reproduce or Copy

I hereby give authorization to reproduce or copy this report, after the customary one year delay.

Ronald T. Owens

Metallic and Industrial Minerals Permit Nos. 9396110003 and 9396110004
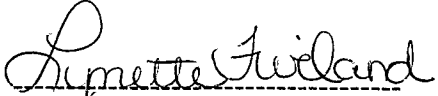
Statement of Expenditures for 2003 - 2004

- -

███████████████████	$ 7,000.00
	5,000.00
Lab materials, equipment and maintenance	4,300.00
Consulting and Custom Services	460.00
Office Expenses	296.00
Lab, heat, electricity and rent	3,286.00
Telephone related to project	908.00
Total	$ 21,250.00

I certify that these expenditures are valid and incurred conducting work related to the assessment of permits 9396110003 and 9396110004.

███████████████

Signed

Lynette Fiveland

Signature/Stamp
Commissioner,
for Oaths

LYNETTE F. FIVELAND
COMMISSION EXPIRES
AUGUST 20, 2007

Record of Expenditures
- - - - - - - - - - - - - - -

Permit 9396110003 required expenditures from Nov 05, 1996 until
Nov 05, 2004 $ 107,520.00

                    actual expenditures Nov 05, 1996 until Nov 04, 2004 $ 120,295.53

Balance carried forward towards 2004 - 2006 period $ 12,775.53

Permit 9396110004 required expenditures from Nov 05, 1996 until
Nov 05, 2004 $ 118,720.00

                    actual expenditures Nov 05, 1996 until Nov 04, 2004 $ 141,545.52

Balance carried forward towards 2004 - 2006 period $ 22,825.52

Allocation of expenditures of $ 21,250.00 during the 2002 - 2004 period to be credited to
permit 9396110004
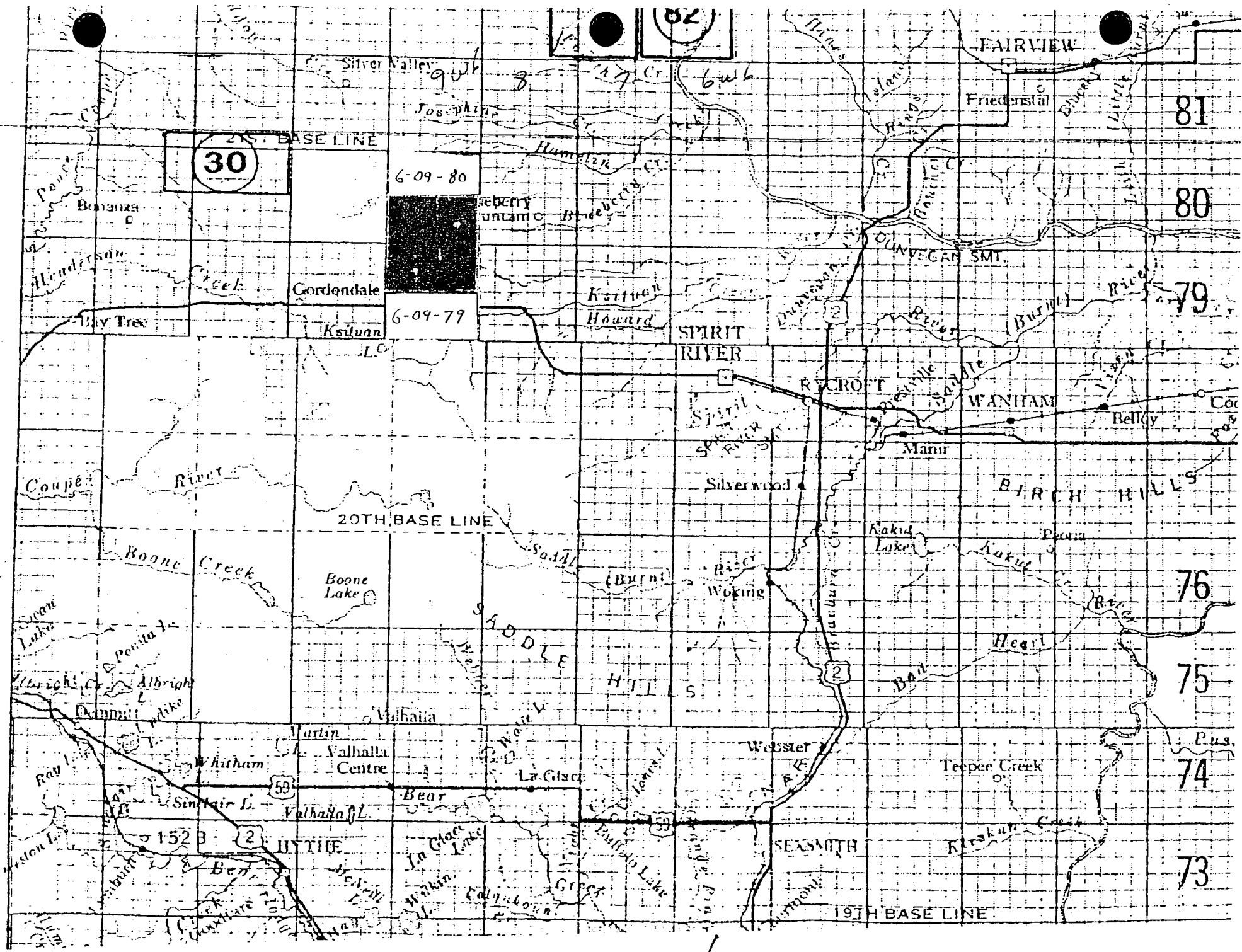
4

FAIRVIEW

Silver Valley

82

BASE LINE

30

6-09-80

Friedenstal

81

80

79

Bonanza

Josephine

Hamelin Cr.

Blueberry

Blueberry Mountain

DUNVEGAN SMT.

2

Henderson

Creek

Gordondale

Kittwen

Howard

Kusluan L.

6-09-79

SPIRIT
RIVER

RYCROFT

WANHAM

Belloy

Bay Tree

Coupé

River

20TH BASE LINE

Spirit River

Silverwood

Manir

BIRCH HILLS

Kakut
Lake

Kakut

Peoria

76

Boone Creek

Boone
Lake

Saddle

SADDLE

Burnt

Woking

Webster

Teepee Creek

Heart

75

Albright L.

Demmitt

Valhalla

HILLS

La Glace L.

Webster

74

Whitham

Martin

Valhalla
Centre

59

Bear

La Glace

Sinclair L.

Valhalla L.

152 B

2

BYTHE

La Glace Lake

59

SEXSMITH

Kleskun Creek

73

Bear

Watkin L.

Callaboun Creek

Buffalo Lake

19TH BASE LINE

Map 1

98-059   1:20K   98-04-30   R   AS4917   4:48
AIR PHOTO SERVICES (403) 427-3520

-119.2792897
55.0543006

AREA COVERED BY THIS REPORT   ----

−119.4034355'
55.9306201
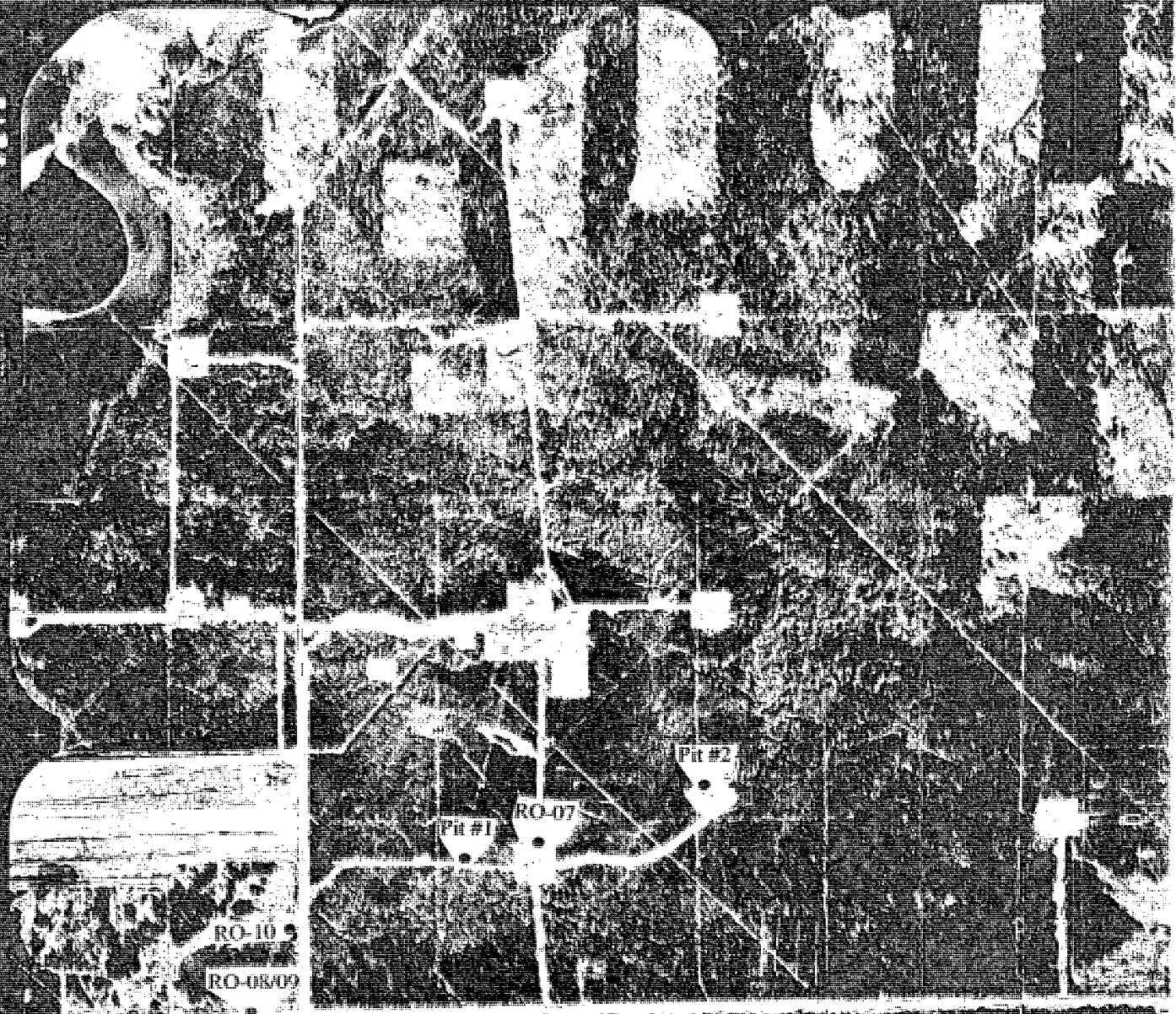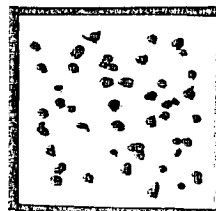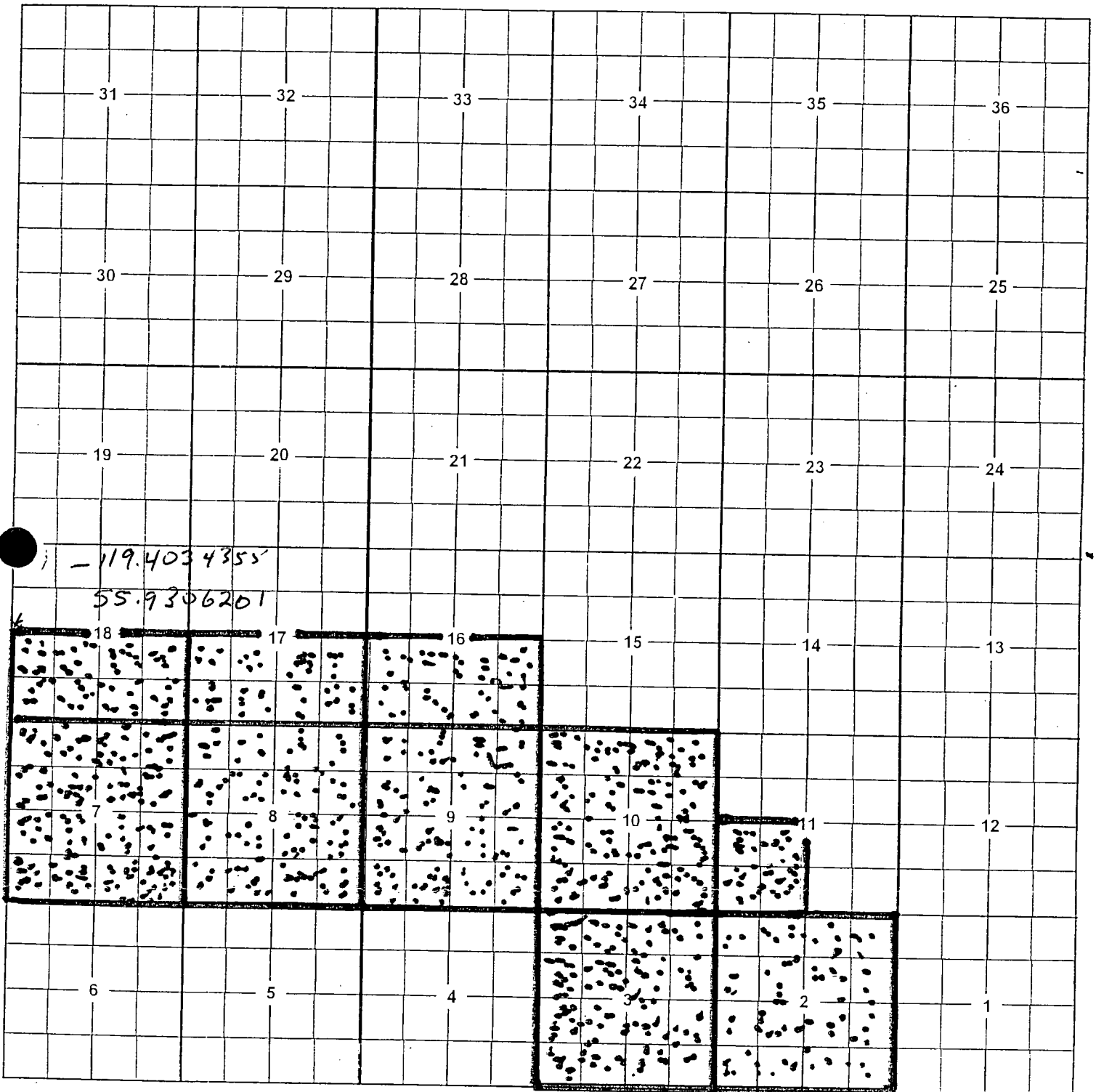
AREA COVERED BY THIS REPORT   ----
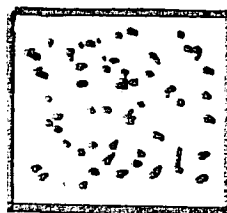
Description of Lab Work for 2003 and 2004

A total of 350 hours were applied to this project in 2003 and 250 hours so far in 2004.

Samples from each one-foot of depth of test-pits one and two were dried and pulverized. These samples were screened, to minus one hundred mesh; this required several regrindings of the plus fraction until accomplished.

Individual samples were then subjected to a halogen leach that was prepared at four different strengths.

In each case, forty grams of each sample would be pre-leached with citric acid before the halogen leach. Another forty grams would be directly leached, without the pre-leach.

The pregnant solution from each sample and sub-sample was filtered and subjected to butyl dyglyme collection. Oxalic acid was used as the stripping agent and the precipitant was collected on a filter paper. This is a very time consuming process and I view it as more qualitative than quantitative.

On August 24 and 25 of 1999, pits one and two were excavated by back hoe. The site locations are described on the photo-map in section four of this report.

After the Chain of Custody program was completed, I collected several hundred pounds of material from each pit.

On April 26, 2002, a pit was re-excavated next to pit one, (photo-map) and material was taken from precise one foot horizons of the pit wall. In the previous work the backhoe operator had attempted to retrieve material in one foot cuts, with each cut dropped in separate piles. About fifteen hundred pounds of material was transported from this pit, and along with the earlier material from pit two, is the subject of the leaching tests of the 2002 - 2004 assessment period.

Although I have used commercial laboratories in the past, I have found the time delay between sample submission and reported results a hindrance to progress. This, along with other reasons, financial and otherwise, have convinced me to do my own lab work at this time.

I have worked with sample material from the Bad Heart Sandstones since 1991. Results would occasionally show precious metal content, but with no recognizable pattern.

This series of tests were done to try and discover such a pattern.

Butyl dyglyme was used as a collector, as it is claimed to be gold specific, and therefore would not require the parting of any recovered values.

My intent was to make the tests semi-quantitative by weighing the Coors Crucible filters, before and after loading. This did not prove successful, as my scale could not weigh the differences on a repeatable basis. Based on previous work, I expected recoveries greater than one-one hundredth of a milligram.

This did not happen in these tests.   When the loaded filter paper is viewed under a microscope, the comparison of one sample to another, is somewhat useful in directing further work.

The leach tests were done in eight, six hundred milliliter beakers, that were heated and agitated at the same time.   This made it much easier to keep the identity of the samples correct.   As the leaching time was eight hours, a very efficient program was created.

The visible results of this work is shown in Table One and Table Two on the following pages.

Conclusions:

1. Leaching time should have been longer.
2. Increasing the amount of oxidizer improves results.
3. The use of a citric acid pre-leach appears to increase the effectiveness of the leaching process.
4. Although the values recovered still do not show any particular pattern, they do show differences in results by increasing the strength of the leach.
5. Although this test work does not indicate commercial potential, a better understanding of the mineralization may lead to more exploration in the general area.

Explanation of sample coding for Tables One and Two:

01 or 02 is the pit number
1' - 2' etc. is the depth of horizon the sample was taken from
A designates citric acid pre-leach
B designates non citric acid pre-leach
thus 01-1'-A is from pit one, the sample material taken from the surface to one foot of depth
        01-2'-A designates material from the one foot to the two foot interval, etc.

In the series of tests 02-9B-2 through 02-8B-2 , the last 2 indicates the second test of the sample.

Table One

Sample	20 ml	40 ml	60 ml	80 ml
01-1'-A	NVM	NVM	NVM	NVM
01-1'-B	NVM	NVM	NVM	NVM
01-2'-A	NVM	NVM	NVM	NVM
01-2'-B	NVM	NVM	NVM	NVM
01-3'-A	NVM	NVM	NVM	VM
01-3'-B	NVM	NVM	NVM	NVM
01-4'-A	NVM	NVM	NVM	NVM
01-4'-B	NVM	NVM	NVM	NVM
01-5'-A	NVM	NVM	VM	NVM
01-5'-B	NVM	NVM	NVM	VM
01-6'-A	NVM	NVM	NVM	VM
01-6'-B	NVM	NVM	NVM	NVM
01-7'-A	NVM	NVM	VM	VM
01-7'-B	NVM	NVM	NVM	NVM
01-8'-A	NVM	NVM	NVM	VM
01-8'-B	NVM	NVM	VM	NVM
01-9'-A	NVM	NVM	NVM	VM
01-9'-B	NVM	NVM	NVM	NVM
01-10'-A	NVM	VM	NVM	NVM
01-10'-B	NVM	NVM	NVM	NVM
01-11'-A	NVM	NVM	VM	VM
01-11'-B	NVM	NVM	NVM	VM
01-12'-A	NVM	NVM	NVM	NVM
01-12'-B	NVM	NVM	NVM	NVM

Abbreviations: NVM = No Visible Metal   VM = Visible Metal

Table Two

Sample	20 ml	40 ml	60 ml	80 ml
02-2'-A	NVM	NVM	NVM	NVM
02-2'-B	NVM	NVM	NVM	NVM
02-3'-A	NVM	NVM	NVM	NVM
02-3'-B	NVM	NVM	NVM	NVM
02-4'-A	NVM	NVM	NVM	NVM
02-4'-B	NVM	NVM	NVM	NVM
02-5'-A	NVM	NVM	NVM	VM
02-5'-B	NVM	NVM	NVM	VM
02-6'-A	NVM	NVM	VM	NVM
02-6'-B	NVM	NVM	NVM	NVM
02-7'-A	NVM	NVM	VM	NVM
02-7'-B	NVM	NVM	NVM	VM
02-8'-A	NVM	NVM	NVM	NVM
02-8'-B	NVM	NVM	NVM	NVM
02-9'-A	NVM	NVM	NVM	VM
02-9'-B	NVM	NVM	VM	NVM
02-10'-A	NVM	NVM	VM	VM
02-10'-B	NVM	NVM	NVM	NVM
02-11'-A	NVM	NVM	NVM	NVM
02-11'-B	NVM	NVM	NVM	NVM

In the following tests, I used 80 ml of nitric acid with 20 ml of peroxide as additional oxidizer in the 400 ml of saturated saline leach for fourteen hours rather than the eight hours as was done in the first series of tests:

02-9B-2	VM
02-10B-2	NVM
02-11A-2	NVM
02-11B-2	VM
02-7'A-2	VM
02-8'B-2	**NVM**

Abbreviations: NVM = No Visible Metal   VM = Visible Metal

Map 1

Outlined in Black is
Section 26-6-09-079
Pit one is on LSD-06, 448 meters
north of the southern boundary &
624 meters east of the western boundary
Pit two is on LSD 08, 682 meters north
of the southern boundary & 1228 meters
east of the western boundary.
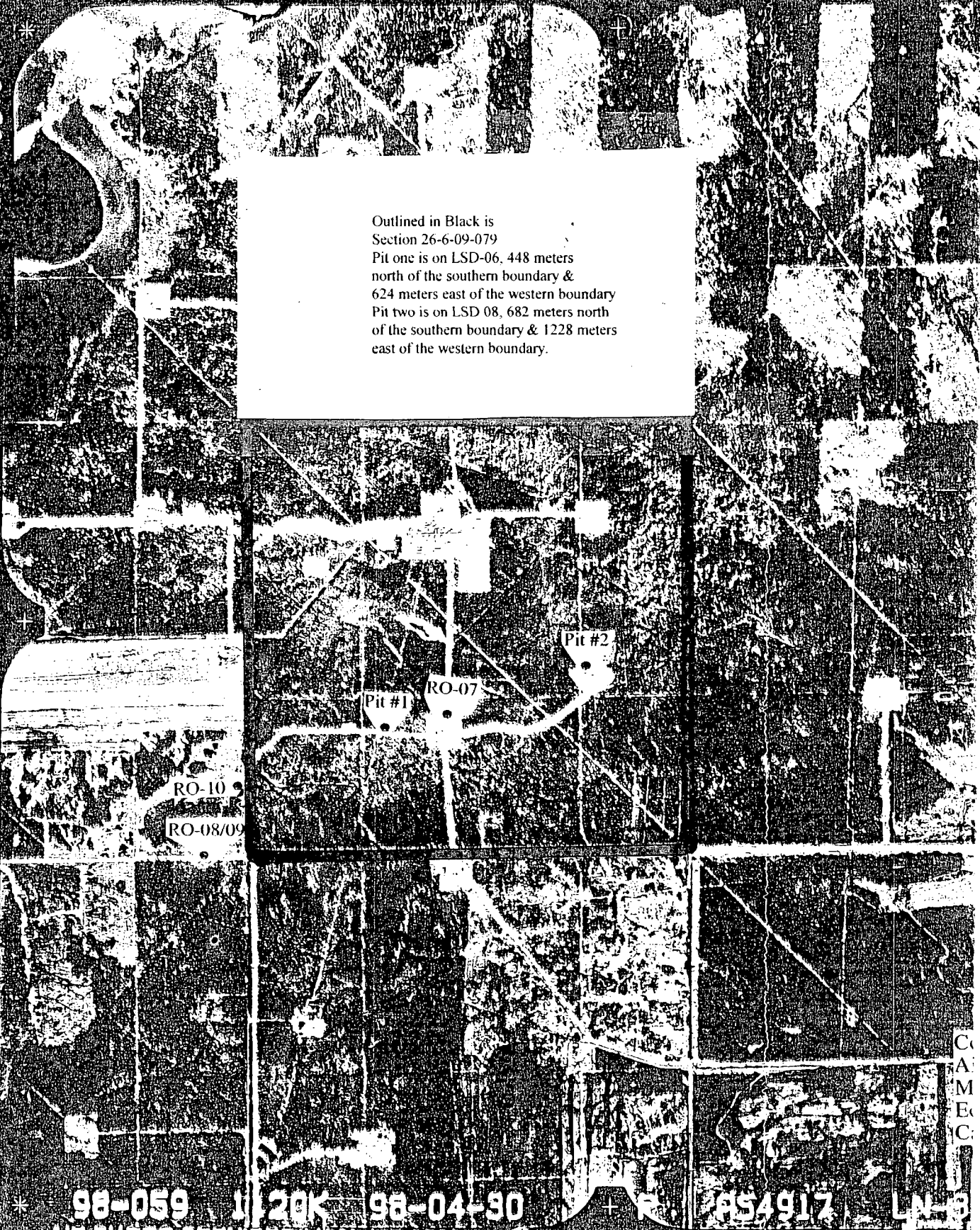
Pit #2

RO-07

Pit #1

RO-10

RO-08/09

98-059   1:20K   98-04-90   RS4917
AIR PHOTO SERVICES (403) 427-3520

Halogen Leaching procedures

This is an all-round leach, to be used in conjunction with an ORP Meter, (Oxygen-Reduction_Potential) to govern the amount of time necessary to oxidize the precious metals into solution.

*Note: This formulation was developed over 45 years ago, commonly used in the mining industry, but seldom revealed to outsiders, recorded in the Mine offices of Santa Gertrudes, Baja Norte, B.C., Mexico, "Alluvias de Oro"

With your ORP meter, keep this mixture between 400mv and 900 mv to avoid co-extracting iron and other base metals. If you wish to run your mixture hotter to speed and enhance extraction, say above 1200 mv., it is perfectly permissable, but if you have iron, pre-treat, as below:

Removing Iron

To remove iron, pre-wash the ground-up ore with Citric acid...a relatively cheap chemical available in bulk that is bio-degradable. Make up a mixture of up to 33% citric acid crystals, and the balance hot water.
This mix can be poured over the ground ore in filters, mixed with ore in a container or used in your ball mill while grinding.
The liquid mixture is then filtered to recover the solids..the liquid now contains dissolved iron. Iron can be recovered by pouring the liquid filtrate through "Greensand", or discarding both into the environment, after diluting it, as it is good for iron-loving, and acid-loving plants.

Leach Mix

Returning to your ore, now make up the leach mix, following this formula:
To each 2 gallons of de-ionized water, or softened (if you have it), heat it to near boiling, adding as much common salt (rock salt is ok) as it will absorb. Allow it to cool.
Draw off 7/8 of the salt-saturated water.
This is the basis of the leach.
Now add 1 to 4 ounces of 7% Iodine to the salt water, depending on how strong you want it. It will turn the leach purple to red color.
Add 1/2 to 1 pint of Nitric acid...again, depending on strength desired.
This then, is your own private "Super Leach".

This leach will dissolve all precious metals as rapidly as cyanide, as long as you keep the ORP high, as I outlined above. Not all ores are the same, like snowflakes, so each one must be tested with varying degrees of the leach.

Ore Preparation

The ore you are using must be ground fine enough to allow the leach to penetrate and contact all parts of the gold and precious metals, in order to dissolve them. This may require a fine grind to 200 mesh or more to release all values. A very reasonable "Ball Mill" can be made from a poly-barrel cement mixer. Northern Tools has one for about $250. Add a couple

of gallons of smooth river rock or quartz to do the grinding, toss in 10-15 lbs. ore, and "Voila"...a Ball Mill!

If using a mixer, the leach can actually be added at this point while grinding it down, if you are satisfied with prior tests.

http://www.northerntool.com/

Leaching

Having mixed 1 part ore and 6 parts leach together, the Nitric acid in the leach will be consumed and lose some potency. You can raise the ORP several points, adding HCL (Muriatic) acid in small amounts as this happens, replacing the Nitric Acid loss, and adding a new dimension to the leach power, helping the high end of the ORP scale, as the lower end at 400 mv is covered by the Iodine. Do not add too much HCL, or you will make Aqua Regia, dragging other, unwanted metals out into solution.

When additions of acid in the leaching process no longer extract any more Gold or Precious metals... it is finished (we will cover that testing in the Leaching manual) it is time to stop, and drain off the Pregnant liquor, containing the metal values.

*Don't leave the leach too long, or it may re-precipitate back onto the ore.---------although this is less likely to happen using this leach formulation, owing to the iodine.

This leach will rapidly extract Precious Metals from prepared ores, slimes and sediments. Gold, Platinums, Silver and rare earth metals will dissolve in a fashion known as the "Electrical Ladder"..the native charge that all metals posess ...Gold heading the list at + 1.36 volts.

Chemical dissolution is the act of this electro-motive force, temporarily applied to put all particles into solution, from which we select what we want through precipitation.

Critical Points on Fire Assaying

RATE OF TEMPERATURE RISE DURING FIRE ASSAY

Before loading, 45 min. warm-up (1070°C).

These temperatures were taken by optical pyrometer readings of the crucible surface during firing.

No. 1 This is a graph of the Rate of Temperature Rise that ASAT has found to be the most successful for assaying microfine gold.

By Walter C. Lashley, director of research ASAT

Fire assaying may be the most misunderstood procedure in the minerals industry.

When an assayer boasts that he (or she) can fire an assay in twenty minutes, smile sweetly and take your sample to someone else.
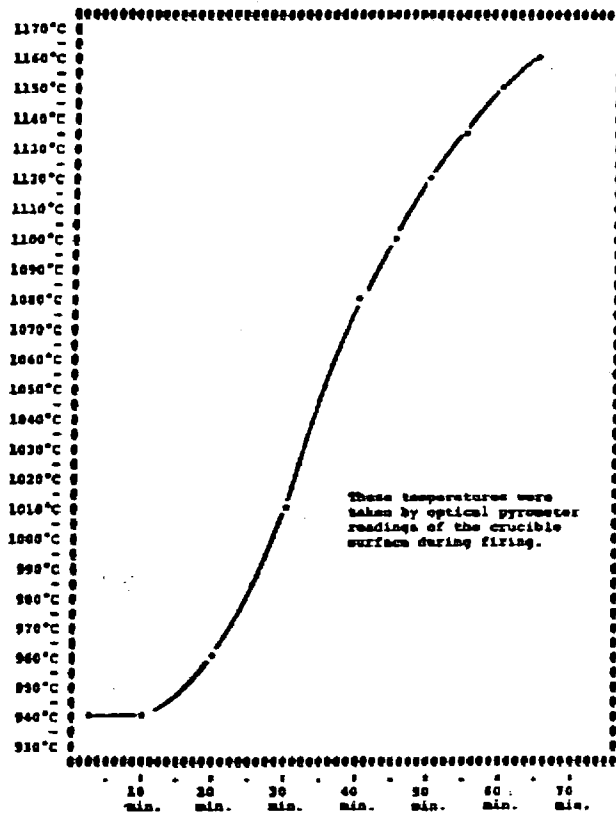
Our previous statement may border upon dogmatic, but we assure you it is not, for during the past five years ASAT's staff has expended over 40,000 man hours, studying the identification and recovery of microfine gold. Several thousands of these hours were devoted to the budding science of fire assay.

In 1588 Lazarus Ercher published the first writing on the subject, and from that time until the present, every writing concerning fire assay has suggested that there was a personal touch provided by an assayer that was critical to successful recovery. These statements fostered the belief that fire assaying was an art, rather than a science.

Were we to present the full explanation and argument for the following statements, it would occupy the next two issues of Popular Mining to the exclusion of all other writings, so we will hit upon a few high points that should help PM's readers get better results from their fire assays.

Rate of Time Temperature Rise

Regardless of the flux that you may be using, there are certain phenomenon that must occur in the melt, and each stage will take an allocated amount of time.

Our first limiting factor is the gradation of the ore. It must be 100% passing a #100 mesh (U.S. standard) sieve. The ore must also be ground with the flux in a mortar, so as to assure intimate contact with the pyrometric chemistry. Should this preparation be ignored, you will halve your chances of recovering any gold under 40 microns (0.04 mm) in size.

Place the crucible with its charge in a furnace that has been preheated (starting from a cold furnace) to 940°C (1724°F which is visible orange) and adjust the fire to maintain this temperature for the next twenty minutes.

During this twenty minutes time period, the internal temperature of the melt will slowly rise to match the chamber temperature and the oxygen released by the litharge (or red lead oxide) will have time to react with the minerals in the ore, oxidizing all of the base metals, so that they may be combined with the fluxing agents.

By using this approach and Slag-master (a computerized method of balancing the fluxing agents to the needs of each ore), we have not witnessed base metal contamination in a single cupel in the last 2000 + firings.

Following the twenty minutes oxidation period, the throttle is opened, so that we may reach a chamber temperature of approximately 1050°C to 1100°C (1922°F to 2012°F, which is visible yellow heat) in the next twenty minutes.

This is the digestion period where the gangue minerals of the host rock are digested and become part of the slag.

Within the viscous melt, the lead mist formed by the reduction of the litharge (or red lead oxide) has the greater part of twenty minutes in which to contact the noble metals and collect them as they are freed from the dissolving gangue.

This would be an appropriate place to point out that if your ore does not carry silver in multiple ounces, then you must inquart silver if you are to collect the microfine gold. (Of the various methods used for inquart, we have found dilute (160 gm/liter) silver nitrate in 1% nitric acid to be" the most successful.   Our normal inquart is one milliliter of this solution, added to the top of the melt just before firing. This gives us a 16 milligram bead of silver to part).

Placing a preweighed block of wood on top of the charge will create a blanket of carbon dioxide and assure you that the lead mist will be present throughout the whole melt, rather than in the bottom third as it would normally occur. This twenty minutes is a critical part of the firing, for if the fluxing were improper and the melt should become fluid too early, the lead mist will drop too soon and the noble metals will remain in the slag.

In this case, particle size is the factor that determines the amount of gold retained in the slag when the melt becomes fluid too soon; ie., the finer the particles of gold, the greater the amount retained in the slag. Should the gold be 10 microns or smaller, you will be lucky to collect 10% of the values in the lead button. A properly balanced flux combined with a well controlled rise of temperature will eliminate any need to re-fire the slag.

During the last twenty to twenty-five minutes of the firing cycle, the temperature is allowed to crawl-up to somewhere between 1150°C and 1200°C (2102°F to 2192°F), which is high yellow to white and difficult to look at without dark glasses).

Crucible temperature (internal) usually lags about fifteen to twenty minutes behind chamber temperature; e.g., it takes twenty minutes for the charge to absorb the heat that surrounds it. This means that over the last twenty minutes the melt becomes more and more fluid allowing even the smallest sphere of lead to settle to the bottom and collect in the button.

Plotting your Temperature Rise
Illustration #1 is the graphed function of ASAT's "Rate of Temperature Rise", and we suggest that you try to approximate it as closely as you can.

Within the minds ear, the author hears voices from potential readers saying "SO WHAT, you are a research laboratory with all kinds of expensive equipment to work with, and I am a starving prospector".

Take a look at ASAT's equipment in illustration #2 before you scream too loud. This shoddy little gas furnace has been in service for over fifteen years; it will handle five 40 gram crucibles at a time and one "L" crucible (for casting 500 ounce silver bars). It is constructed of loose laid K26 light weight fire brick within a simple angle iron frame. Asbestos board sides keep the brick in place. The real secret of this furnace is the 75,000 BTU venture burner that brings it to life.

Illustration #3 shows the burner, which costs $28 and can be bought at ceramic supply houses. If   the furnace that you design is 1.3 cubic foot (inside volume) or smaller, the temperature rise that we have described presents little or no problem.

ASAT does have an edge on keeping track of the temperature, for we use a visual pyrometer as well as voltaic pyrometers.

By placing two valves in line, one to limit the maximum flow and the second to control the flow from 0 to maximum, you can trim these burners out to the point where you fire with a stop-watch and no longer have any need for pyrometric readings.

Should you use a bimetal, voltaic pyrometer, we would suggest that the cycle be determined with a brand new probe, for they oxidize over time and lessen the bimetal contact area, which in turn causes the millivolt meter to give an erroneous reading.
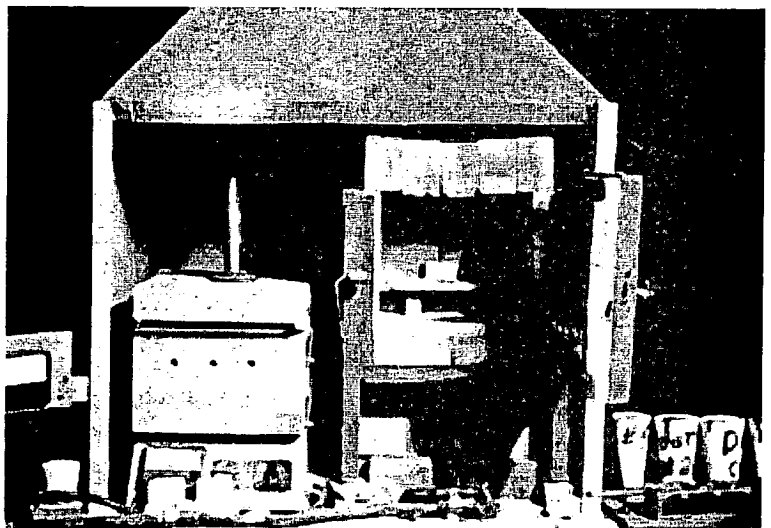
No. 2 ASAT's homemade furnace has fired thousands of samples over the years and has been rebuilt several times. It takes less than one hour to put a new deck in the furnace and replace any damaged brick in the walls.
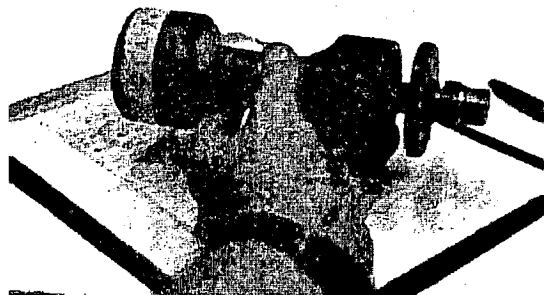
No. 3 This 75,000 BTU venturi burner costs approximately $28, and may be purchased with an orifice for city gas or bottled gas.

If you do not have a pyrometer (about $100 buys one from a ceramic supply house) and/or wish to know exactly what is happening within your furnace, you should buy some pyrometric cones (once again from a ceramic supply house) and a few cone holders.   (See illustration #4).

We would suggest that you use small cone 09 which will bend horizontal at 955°C, small cone 05 which bends at 1062°C and small cone 02, which is rated at 1148°C.

By viewing the cones through a peep hole (1/2") in the door of the furnace, you can time the advent of each temperature point during the plotting of your adjustments. Be sure to have charged crucibles in the furnace at the time, for they will alter the curve drastically.

Is it worth it?

Yes. The time and trouble of compounding a customized flux and firing it properly will pay off every time, for it will grant you the capability of producing repeatable results when firing the same sample multiple times.

At our laboratories, we have several samples that we use for control just to check-up upon our own assaying ability. One such sample (desert placer) has been fire assayed fifteen times to date and fourteen of the fifteen rendered 0.05 ounces per ton. The one that missed was used in an experiment to prove or disprove the importance of controlling the rate of temperature rise.

No. 4 Pyrometric cones, which are a standard means of measuring temperature in the ceramic industry, may be used as a means of checking the temperature in an assay furnace.

We performed three firings that day and allowed only one hour for the furnace to cool down. This meant that we were building residual heat deep within the fire brick and our rate of rise would increase with each firing. That is to say that the point of fluidity would be reached several minutes earlier with each following firing.

Firings #1 and #2 produced the anticipated 0.05 from the control sample, but firing #3 dropped to a visible trace, which could not be weighed.

We cannot help but wonder how many viable mining situations have been condemned because the assaying community is unaware of this phenomenon.

More, if you wish

We have tried to crowd a lot of information into one brief article. Hopefully, it has not been too much and too brief; however; if you would like more information about these subjects, we at ASAT publish bulletins and video tapes on our work and moreover, we would like to encourage you to join ASAT and support our efforts.

ASAT is a non -profit scientific foundation that is supported entirely by its membership and the projects that they fund. Not one cent of tax money is involved. That is except for the taxes that our members do not have to pay on the projects that ASAT is involved with, for they are covered under an IRS 5 01 (c) (3) exemption.

For membership information, write:
ASAT , P.O. Box 1705, Silver City, NM 88062, or call (505)388-5654

Tel: (0500) 54 65 32   Fax: (08) 9389 5647   Home tel : (08) 9389 5648
http://members.iinet.net.au/~menne/aumet.htm   menne@iinet.net.au

However amyl acetate is relatively soluble in water, again
necessitating pre-equilibration of the extraction solution
and the aqueous acidic media as noted above for MIBK.

Hach [Selby-Biolab, Mulgrave North, Victoria] supplies cheap,
effective colorimeters for quantitative analysis.

Alternatively for simple low level detection, Thin Layer
Chromatography techniques might be developed. This technique
relies upon the differences in partition coefficient of the
species being assayed, generally based on polarity. A spot is
placed on eg silica gel [very polar], whereafter a [generally
les polar] solvent is allowed to diffuse up the plate.

Compounds that like to partition more to the solvent [generally
less polar] and be pulled further up by it [high Rf = ratio of
[distance travelled by compound]/[distance travelled by solvent
fron] from spot]]; and vice versa.

For relatively volatile solvents, enclosure could prove
necessary to envelop the test plate in saturated solvent vapour.

12.2 UNDER-ASSAYING OF GOLD :
PSEUDOSCIENCE OR A NEW FRONTIER ?

Two relatively unusual under-assaying phenomena, which can at
least be credited with some reasonably sound basis, exist :

[a] Moderate temperature volatilization

[b] Natural speiss in basaltic rocks

By contrast, a number of other unusual phenomena indicating
under-assaying are still struggling to gain credence, including
extensive milling, high dilution and direct slurry electrolysis.

12.2.1 UNDER-ASSAYING OF GOLD BY MODERATE TEMPERATURE VOLATILIZATION

United States Bureau of Mines research, discussed in Appendix IV, reveals how easily gold might be volatilized by halogens.

Lashley further suggests :

[a] That gold might also be lost if gases such as hydrides are being generated at such a high rate that gold is swept with them

[b] The use of [Purple of Cassius] test papers to establish if any gold loss by volatilization is occuring.

Considering the known technology of ion flotation, gold could possibly be discharged by the fine mist caused by excessive effervescence.

In practice the use of a watch glass seems to address a lot of the problem.

However the problem could be further contained by the proposed prophylactic measures of :

[a] Applying less vigorous conditions, inter alia by :

   [i] Starting with lower acid strength, and

   [ii] Applying lower digestion temperatures [under 70 C]

[b] Reflux, and/or

[c] Most importantly, never allowing the sample to boil dry.

12.2.2 UNDER-ASSAYING OF GOLD IN NATURAL SPEISS IN BASALTIC ROCKS

A C Johnson [1997]. The detection of precious metals in basaltic rocks, International California Mining Journal, July, pages 14 & 15; notes that basaltic rocks collected from within the general confines of the Pacific Rim can contain a natural speiss which might contain up to 50000 g Au/t.

This natural speiss is typically irregular to palletial, up to a few mm in size and running around 1 to 3% of the rock mass.

It is substoichiometric [ie generally lower in As/Sb than metallurgical speiss] with Fe, Cu and SiO_2 predominant, and subordinate [under 10 to 15%] of As, Sb, Te, Se, Hg, S etc.

This natural speiss is generally zoned with the periphery composed largely of Fe with little or no Au content; and is resistant to attack by dead roasting, acid digestion and fusion.

It also tends to form a metallurgical speiss in fire assaying, which retains Au.

Johnson suggests an assay procedure where :

[a] The natural speiss is physically concentrated

[b] Intimately ground with 10x as much litharge for 2.5 hours
   [5 gramme speiss plus 50 gramme litharge]

[c] Dead roasted for 2.5 hours at 450 C
   [can in some cases be dispensed with]

[d] Blended with :

   50 gramme sodium carbonate
   30 grammes borax
   1.4 grammes carbon black
   3 grammes silica

[e] Fused for 1 hour at 1100 C [clay crucible, electric

furnace]

[f] Pb button cupelled at 950 C

12.2.3 CONTROVERSIAL PROCESS TECHNIQUES

No thorough discussion of gold assay inconsistencies would be
complete without reference to the controversial aspects of gold
underassaying. This material is not dealt with in the main
report largely because it is still so controversial - even after
a decade of sometimes inequivocable demonstration.

These mechanisms should be kept in mind, as the phenomenon might
be true; more widespread than thought; and play some role in the
differences in gold balances achieved by hydrometallurgy versus
Fire Assay, or even Neutron Activation.

Fire Assays demonstrating around 0.1 g Au/t, which yielded 2 to
3 orders of magnitude more by special extraction [Elazac process
- milling using 100's kWh/t] were claimed by Haoma Mining Ltd
[Gary Morgan] in their 6 March 1995 Special Report to the Stock
Exchange. Their statements were supported by respected ex-CSIR
scientist Dr Peter J Scales, BSc(Hons)(Melb), PhD(Melb).

Similar results have been confirmed for the Action Gold Process
[low solids content lixiviation] by inter alia the Kalgoorlie
Metallurgical Laboratory [Dr Jim Kyle - see their report,
Certificate Number 16258A] and the Colorado School of Mines [Dr
Rex Bull]; 10-20 g Au/t prills being fired out of ore
conventionally assaying one to two orders of magnitude lower.

The Action Gold Process recoveries appear to be generally better
if the gold is brought into solution as complexes not easily
adsorbed, viz anionic complexes of high charge density, or
cationic complexes; and if dilution and/or dispersants minimize
interparticle contact zones and/or chelates.

Butler [1990]. Analysing "Classically Unassayable" Gold. Randol
Gold Forum, Cairns; has provided evidence of the tight
association of gold in the region of interparticle contact
zones, which is reduced by increasing particle dispersion
[dilution, dispersants] is confirmed by Steensma [1989] who

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demonstrated that some gold desorbs on dispersing solids
particles by ultrasonics - the effect being reversible [and
affected by the addition of "a bonding chemical" [chelating
disperant ?].

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The fact that introducing electron-rich solvents such as ethanol displaces such gold anions indicates that one is probably not dealing with water in this layer as we traditionally know it - electrostatic ordering will reduce the dielectric constant from the "chaotic" value of around 81 in bulk solution to nearer 6, with corresponding reductions in the "solubility" [entropy ordering] of adsorbed precipitatable species.

With this entropy ordering, anions might be able to better overcome energy barriers to be able to approach gangue lattices closely enough to be held by amazingly strong ultra-short-range London forces, which do not allow them to be given up back to solution when assaying.

Underassaying might thus correlate with high contact point quantities, ie subcolloids of the right mineralogy [ie capable of providing amazingly strong ultra-short-range London force lattice bonds]. Neutron activation is also said to fail in revealing the gold which can be recovered by these processes.

In neutron activation analysis [NAA], samples are exposed to a neutron flux which makes many contained elements radioactive. Unstable isotopes formed emit radiation, including penetrating Gamma rays. The energy levels of these Gamma rays are distinctive for each element, allowing elemental analysis by measuring the Gamma ray energy spectrum with high resolution detectors.

The limitations generally accepted include :

[a] Some common elements (e.g. sodium) activate very easily and raise the background radiation levels to a degree that they adversely affect the detection limits for some other elements.

Those elements which have a longer halflife as compared to gold are particularly problematic.

[b] As with other spectroscopic techniques, the presence of a large amount of one element can cause difficulties with the measurement of another through spectral overlap.

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[c] Self-shielding of a sample can occur when there are coarse
grains of easily activated minerals present.

This will result in low values for the elements in the
shielded materials.

[d] Turnaround times can be slower by NAA than by other
techniques because of the need for cooling times; some
elements such as rare earth elements must be counted
several times at different intervals for best results.

It should be noted that in Synthetic Rutile production, intense
acid treatment aimed to reduce radio-activity by dissolving out
the offending species actually increased it. The evidence is
that intimately associated species which absorb such radiation,
eg Ba, were being selectively removed in this process.

One would thus expect certain elements to cause under-reading by
this mechanism as well.

The following elements in abnormal concentrations could absorb
decay and bias gold results low :

[a] Rare earths

[b] Boron

[c] Cadmium

[d] Lithium

[e] Uranium

The presence of a dominant radioactive element which has a
longer halflife than gold could raise the background such that
the response to gold is less sensitive.

Apart from errors related to these mechanisms, it might be
possible that distortion of the energy spectra of these rays
might occur under certain circumstances, causing underassaying.

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This is a controversial subject, although very significant underassaying was demonstrated eg by comparative gold balances on precipitated iron oxides by Neutron Activation, in research executed by Catherine Greffie of the Dept of Agriculture UWA [Randol '95 poster paper on her PhD project], which requires airing.

An explanation based on gold atomic bonding might provide an explanation for these experiences.

USA Patent 5770036 by Ahern ao, assigned to the Massachusetts Institute of Technology provides an extensive list of references which discuss the quantum physics which might underly such phenomena.

A simpler outline could be formulated as follows :

Gold forms as a face centred cubic mineral, ie the bonds within internal octahedra occur in a KZ12 lattice.

So-called dangling bonds emanate from surficial gold, being electrons attempting to pair with compatible species.

The compatibility ranges from high, for soluble species such as silver or alloy compounds such as calaverite, to moderate for lattices which accomodate gold fairly well such as bismuthinite, to low for most oxides.

The energy levels of the gold atomic substructure are consistent for each atom of gold totally bonded internally within its own KZ12 lattice structure.

The energy levels could also be expected to be fairly similar for gold atoms where the surrounding lattice is compatible.

However where the surrounding lattice is incompatible, as for most oxides, the failure of the dangling bonds to achieve pairing is believed to reflect itself in altered energy states for the atomic substructure for the gold atoms so affected.

Techniques such as neutron activation, which are reliant upon the

crystalizing with the FCC structure, gold has only a few
resemblances with other Group II elements.

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There are at least two theories regarding the non-assayable clustered gold, and how lengthy grinds or electrolytic processes achieve gold recovery - but with inconsistent results :

" [a] The first theory is that the clusters under extreme energy release in their proximity during the grind become temporarily available to colloid chemistry and collection.

[b] The second is that clusters have charges to them. They are mono-polar.

Micro-molecular minerals such as zircons with traces of halfnium and iron oxide inclusions are attracted to the microclusters and form dense refractory encapsulation of the gold clusters.

Therefore the refractory protection is keeping the gold inside of micro-jails. The values just can't get out.

This will explain the reason that neutron activation analysis will not detect gold in these samples.

Zircon is a tremendous absorptive mineral, and the neutrons cannot get to the gold for detection.

Now if electrical energy of any kind in sufficient quantity is passed through the "jailed" cluster of gold, the charges are temporarily disrupted and the gold cluster can be recovered by a number of chemistry and possibly physical methods.

A gold value is collected, concentrated and recovered.

Allow the sample to sit for a period of time and the encapsulation of the cluster redevelops."

Unfortunately, until these murky waters yield to science; they remain populated by charlatans and sharks.

Professor P Schwerdtfeger of Aukland University notes that despite sharing features such as $d10s1$ structure and all

effects of the energy states of the atomic substructure might thus become unreliable when a large proportion of the gold atoms are unbonded or ineffectively bonded, viz highly or nano-dispersed in an oxide matrix.

This mechanism also opens up the feasibility of other species mimicing gold by these assay techniques, when their surficial atoms are stressed to non-bonding states which produce energy states in their atomic substructure corresponding to unstressed gold.

It is also appropriate to note that low Fire Assay values for highly dispersed species are not uncommon, and plausible given the reduction of collection efficiencies with reductions in size. The revelation of additional gold on re-assaying [by Aqua Regia or by Fire] of slag produced during Fire Assaying on gold occuring in acid-resistant oxide gangue, is not uncommon.

Finally, a number of speculative USA projects in the Arizona/Nevada chastity belt [so named as gold stock investors are advised to wear them there] are based upon processes alleged to recover gold which is conventionally unassayable.

Such processes include high energy imput milling, and extended electrolysis which could progressively deplete hyper-adsorbed gold.

The gold behaviour is said to occur as the atoms occur as clusters. The cluster can be mono-elemental (One Metal), like the Au5 or Au7 micro-clusters; or it might be like Au39 as a part of an organic enzyme, compound or caged species; or AuAl as an elemental bi-atomic alloy; but whatever the case, these individuals species, because they all can be found in the same sample, make the recovery and refining complex.

Statements exist that if you take an cluster resource sample that contains gold and grind it by violent means, and follow up with processing, the sample may yield gold. Four hours to 3 weeks later the sample will yield nothing. Repeat the grind and it will again produce gold, at least for a while.

Au has unusually high ionization potential and electron affinity; and shows unusually large force constants and small interatomic bond distances. Some gold compounds show strong dispersive [termed aurophilic] interaction.

It has only been realised in the last two decades that relativistic effects are responsible for these anomalies, and material published by him in on this subject indicates that he might be able to shed light on the matter :

P Schwerdtfeger and M Dolg [1991]. Anomalous high gold-metal bond stabilities : relativistic configuration interaction calculations for AuLa and AuLu. Phys Rev A, volume 43, page 1644.

P Schwerdtfeger and G A Bowmaker [1994]. Relativistic effects in gold chemistry. V. Group II dipole polarizabilities and weak bonding in monocarbonyl compounds. J Chem Phys, volume 100, page 4487.

12.3 POINTERS

Laboratories [such as the Geological Survey of Finland] offer low-cost fast turn-around services for element suites, generally aimed for geochemical mapping and prospecting, but potentially useful for classifying orebodies by their mineralogical metallurgy. Examples include :

[a] The precious metals suite : Au, Ag, Pt, Pd

[b] Pathfinder elements : As, Bi, Se, Te

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CHALLENGES IN GOLD EXTRACTION

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