Moose River Gypsum

Industrial Mineral Testing Program

December 1997

Prepared for James Bay Lowlands Gypsum Development Group

By New Worlds Engineering

2.18060

Industrial Mineral Testing Program - Moose River Gypsum

Goal

Perform fabrication and processing tests to illustrate the concept of using locally derived sawdust and planer shavings as filler for Moose River Gypsum. The addition of filler should increase toughness of the composite material. The increase in toughness will be illustrated as an increase in the maximum compressive strain to failure observed. Impurities and atypical forms of gypsum can cause problems for bonding between the wood material and the gypsum stucco. The tests performed here will provide a proof-of-concept for the production of wood-fibre reinforced gypsum products.

Gypsum

Gypsum is a non-metallic mineral, found as a rock composed of 79.1% calcium sulfate and 20.9 % chemically bonded water by weight (calcium sulfate dihydrate $CaSO_4 \cdot 2H_2O$). Gypsum was formed during the Silurian period of the Paleozoic Era of the geological calendar. This corresponds to approximately 300 million years ago. In absolutely pure form, gypsum rock is white. However, as found in nature, it most often contains impurities whose presence makes the rock appear gray, brown, pink and even black.

The water contained in the structure gives this mineral some particularly useful properties. Gypsum readily gives up, or takes on this crystalline water. With the application of a moderate amount of heat in a process known as calcining, gypsum is converted into what is commonly called "Plaster of Paris" or stucco. This hemihydrate calcium sulfate ($CaSO_4 \cdot \frac{1}{2}H_2O$) can easily be changed back to the dihydrate form by simply mixing it with liquid water. Conveniently, there is a certain "setting" time between the addition of water, and when the dihydrate becomes fully solid. This means that the mixture can be shaped before it hardens.

Gypsum and its products have been known and used from the earliest times. The Ancient Assyrians called it Alabaster and used it for sculpting. Five thousand years ago the Egyptians had learned to make plaster from it. The ancient Greeks named this mineral "Gypsos", from which came the name "Gypsum". One particular form of the mineral, clear and transparent in layers like mica, was used as temple windows many centuries before glass was invented. The Greeks called it "Selene" after the moon goddess - today we call it Selenite.

In modern times gypsum is used in the manufacturing of many products including: drywall board, plaster, sheathing, toothpaste, blackboard chalk, and as filler in paints. It is also used as a surgical casting material and molds for false teeth.

In the gypsum industry, calcining is the step of reducing dihydrate to hemihydrate or anhydrous ($CaSO_4$) form. In the very early history of gypsum plaster production, pieces

of rock were simply heated in an open wood fire to bring about the dehydration process. Today, stucco is produced using sophisticated vertical kilns or fluid bed roasters. Quality control of mined material has become critical in terms of impurities, sizing and separation of natural anhydrates. These factors have been found to significantly alter the form and usefulness of the stucco produced. Laboratory tests, such as the type performed for this report, are the first step in determining the possible uses of the gypsum found in the Moose River area.

Reinforced Gypsum

The concept of fillers added to a gypsum matrix has existed since the first gypsum blocks were formed by the Egyptians. Fibrous materials, such as straw, not only increase the volume of the material available, but they also increase the toughness of the hardened gypsum by acting to stop the propagation of cracks. Blocks and other shapes containing fibrous materials are less susceptible to impact damage or tensile loading damage. Although the addition of some filler lowers the ultimate strength of the material, the increase in toughness often makes up for the loss through an increase in usability. The blocks would be less likely to break during handling, for example. In recent history fibrous fillers have also been added to gypsum to increase its usability. In Europe and Asia fibre-reinforced gypsum wallboard is used in a variety of general applications, particularly where some bending or curving of the wallboard is required, or where rougher use is expected. In today's expanding market for new construction materials in North America the production of wood fibre reinforced gypsum wallboard may be the next possible step as we move along the market path established by oriented strand board (OSB) and medium-density fibreboard (MSD) users.

Testing Procedures

50 kg of raw gypsum was ground and screened to 100% < 100 mesh. Hemihydrate stucco was produced by calcining the ground gypsum for one hour at 180 °C to 200 °C and normal atmosphere.

A slurry was produced by mixing 100 g of the gypsum stucco with specific amounts of water (see Table #1). The amount of water was chosen to reflect the amount and type of wood fibre in each particular test mixture. The slurry was then mixed with various amounts of wood fibre. Two types of wood fibre were used in this program, sawdust and $1cm^2$ planner shavings. Test batches were produced by mixing slurry and wood fiber to obtain a uniform consistency. The mixture was then poured into square molds measuring 3 cm^3 (Block #1-6, Table #1). Control batches, without wood fibre, were produced using gypsum and specific amounts of water only. (Block #7-9, Table #1). After pouring, the test blocks were allowed to set in the mold for 2-3 minutes. Once set they were removed from the molds and dried at room temperature in air for 24 hours.

The hardened blocks were tested by applying a controlled load using a table mounted vice. The load was recorded as torque applied to the vice screw using a torque wrench. The torque is directly proportional to the load or stress applied. Compression distance and torque were measured as the vice screw was turned. The breaking point and structural failure of the blocks was noted in each case, along with general observations about the method of failure. Forty-six blocks were tested in this program.

Table #1: Mixture data for blocks formed.

	Stucco	Sawdust	Shavings	Water	Slurry	Dry Wt.	Filler
	(g)	(g)	(g)	(ml)	(g)	(g)	(% total)
Block #1	100	14		80	194	122.5	11.4%
Block #2	100		7	80	187	114.7	6.1%
Block #3	100	28		100	228	148.6	18.8%
Block #4	100		14	100	214	125.3	11.2%
Block #5	100	32		120	252	150.7	21.2%
Block #6	100		21	120	241	138.3	15.2%
Block #7	100			80	180	101.6	0.0%
Block #8	100			100	200	106.9	0.0%
Block #9	100			120	220	111.6	0.0%

note:
- 100g of stucco = approximately 100 ml
- 14 g of sawdust = approximately 100ml
- 7 g of shavings = approximately 200ml

Results and Discussion

As expected the addition of a filler decreased the ultimate breaking strength of the blocks formed. As shown in Figure #1, the breaking torque as measured for the pure gypsum blocks was higher than either the sawdust or shavings filled blocks.

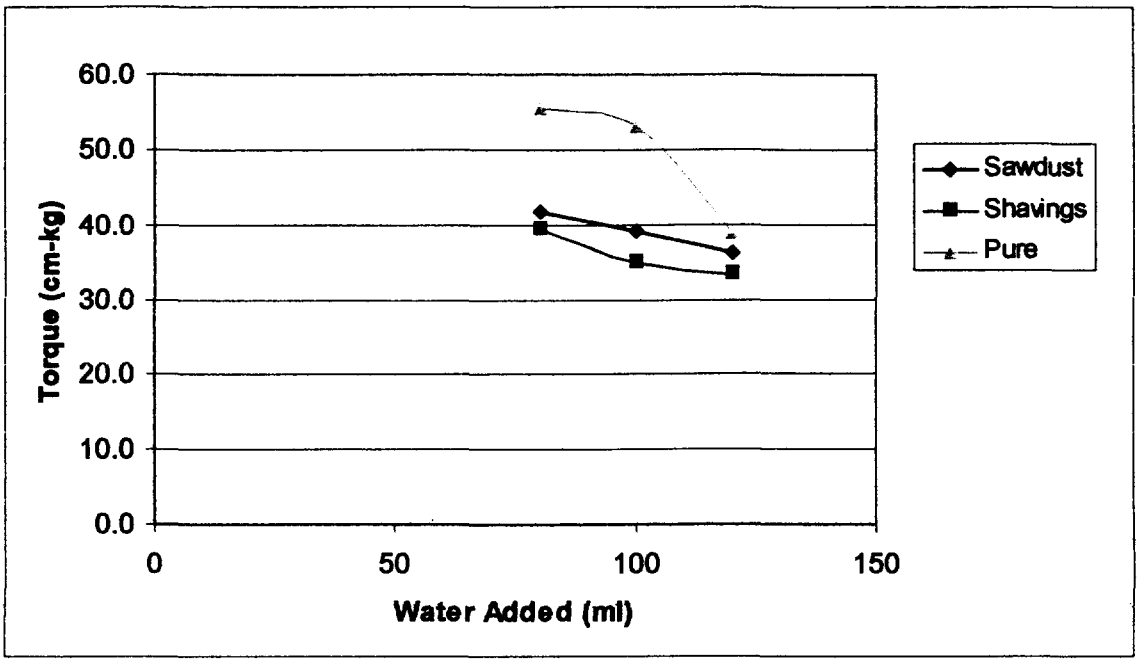

Figure #1: Average breaking torque measured for each group of test blocks.

The breaking torque was defined as the torque measured at which the block fractured. Breaking torque decreases with increase water added since the excess water interferes with the bonding process within the gypsum and also between the gypsum and the wood material.

Maximum compression strain (strain capacity) also changed with the addition of fillers as shown in Figure #2 below. With the addition of the wood material into the gypsum matrix the block became capable of withstanding much greater strain before they failed. It was noted that even after the block cracked the load could still be applied to the block without destruction of the block itself. The decrease in maximum strain capacity by the pure gypsum as more water is added is a normal function of the decrease in ultimate strength due to excess water in the mixture before setting. In all cases though the strain capacity of the pure gypsum was effectively as low as or lower than the gypsum with wood filler added. The addition of larger amounts of filler allowed the blocks to be strained (deformed) nearly two times more than the unfilled gypsum.

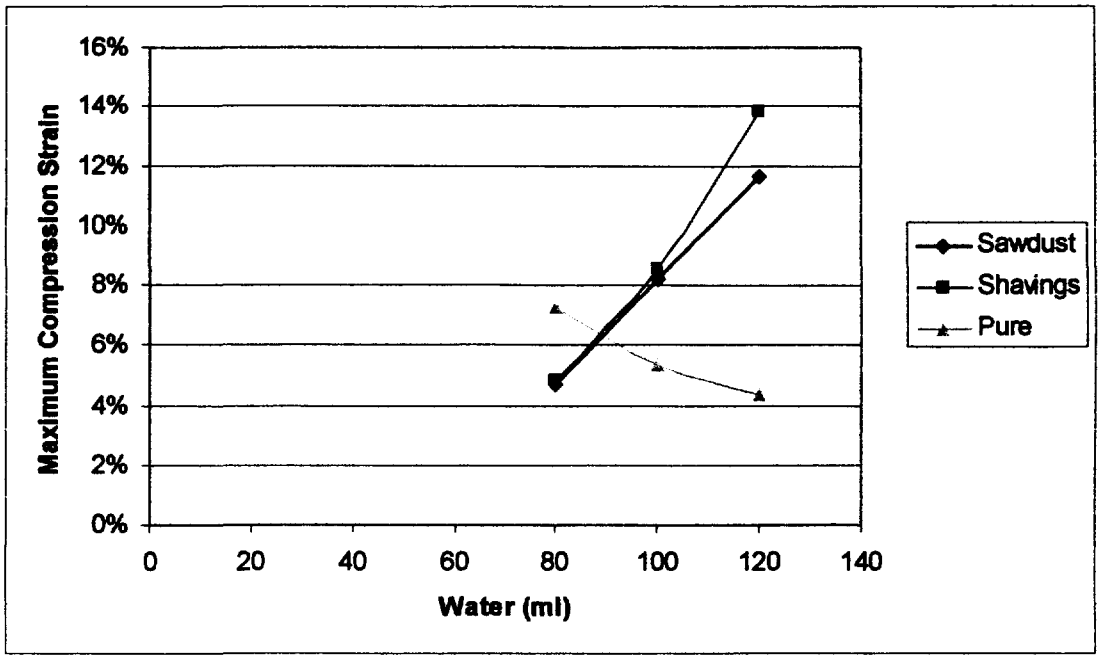

Figure #2: Maximum average compression strain measured for each set of blocks.

To examine the effect of adding various amounts of filler material, both breaking torque and maximum compression strain can be reviewed. The amount of filler in each sample is illustrated using a percentage of the complete weight of the block. Filler percent of total is calculated by dividing the mass of the wood added, by the total mass of the block. These numbers are shown in Table #1 above. Figures #2 and #3 show the effect of filler percent on the breaking torque and maximum compression strain respectively.

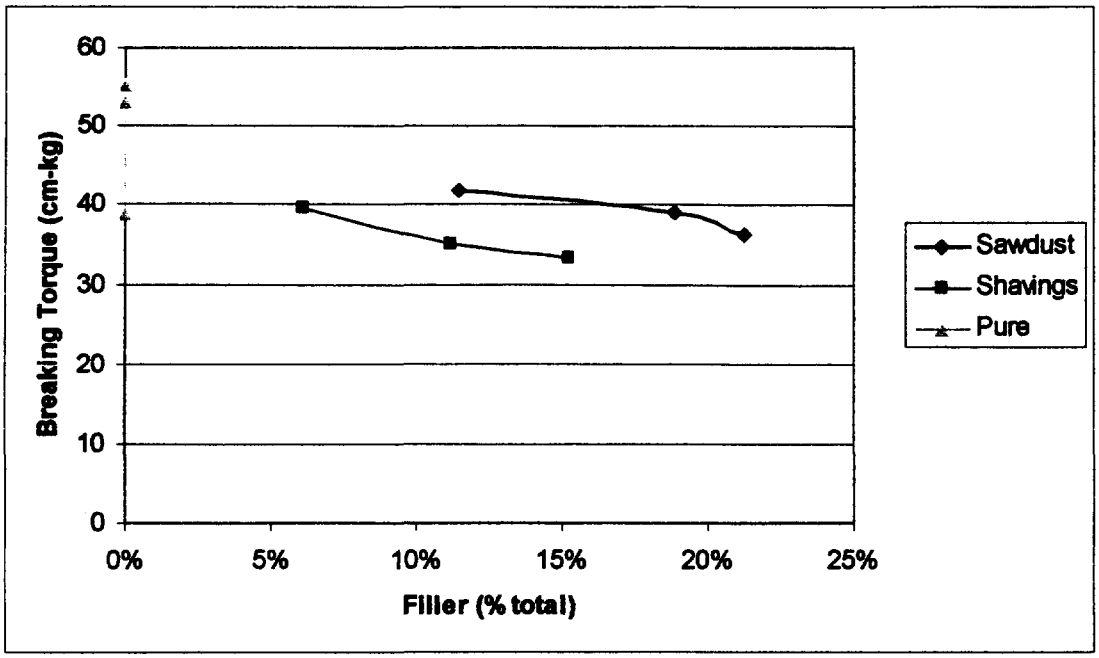

Figure #3: Breaking torque vs. filler percentage of total mass to show the effect of adding larger amounts of wood filler to mixture.

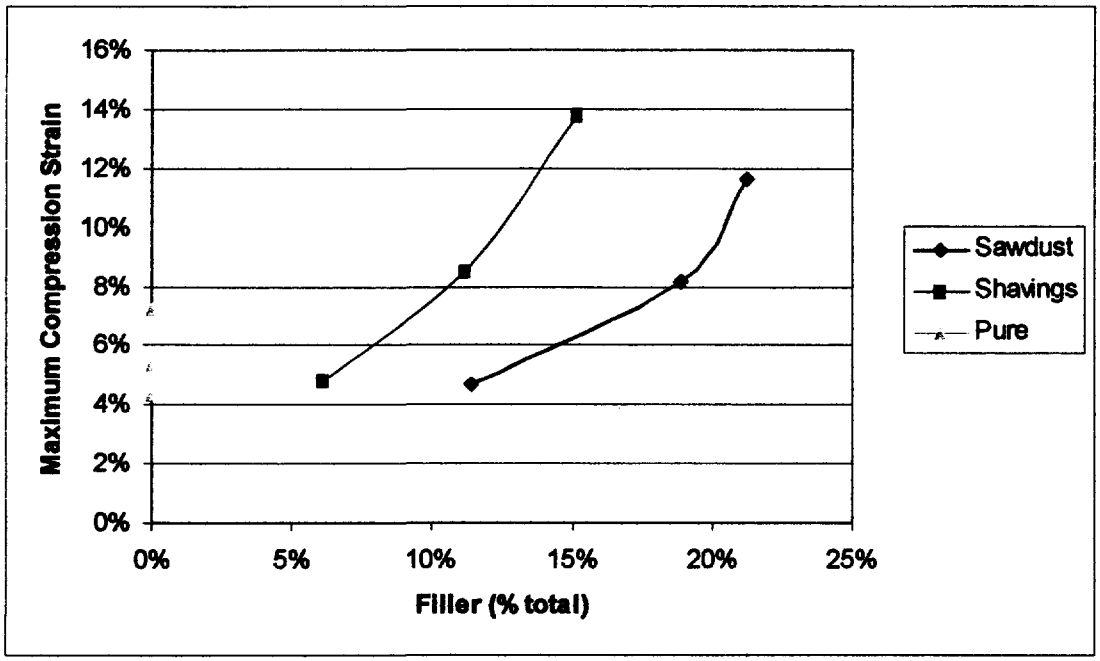

Figure #4: Max. compression strain vs. filler percentage of total mass showing the effect of adding increased amounts of wood filler.

Breaking torque clearly decreases with larger amounts of filler material, both for the sawdust and the shavings added. Of course all the measured numbers for both breaking torque and max. compression strain appear along the left axis of the graphs

above since pure gypsum stucco has no filler added. Maximum compression strain is clearly increased as more and more filler is added. In Figure #4 the effect of using the two different filler materials is clearly illustrated. The sawdust (smaller is size and more variable in size) is less effective at increasing the strain capacity of the composite, but it does preserve a greater breaking torque. More volume of sawdust is required compared to the shavings. Twice as much sawdust (by mass) must be added to the mixture to achieve similar results as the shavings. The larger, flatter shape of the shavings can account this for effect. At the highest amounts of filler added, the material formed becomes effectively a gypsum bonded wood material. Most of the strength is given by the wood shavings. The gypsum acts as the "cement" holding the block together, but provides only a small portion of the strength.

Conclusions

Moose River gypsum, with only normal processing and treatment, appears to perform well with locally derived waste-wood sawdust and shavings. The gypsum and wood bonded well, and the results obtained during mechanical testing of the composite formed indicate that usable products should be viable using simple mixes of gypsum and inexpensive waste-wood sawdust and planner shavings.

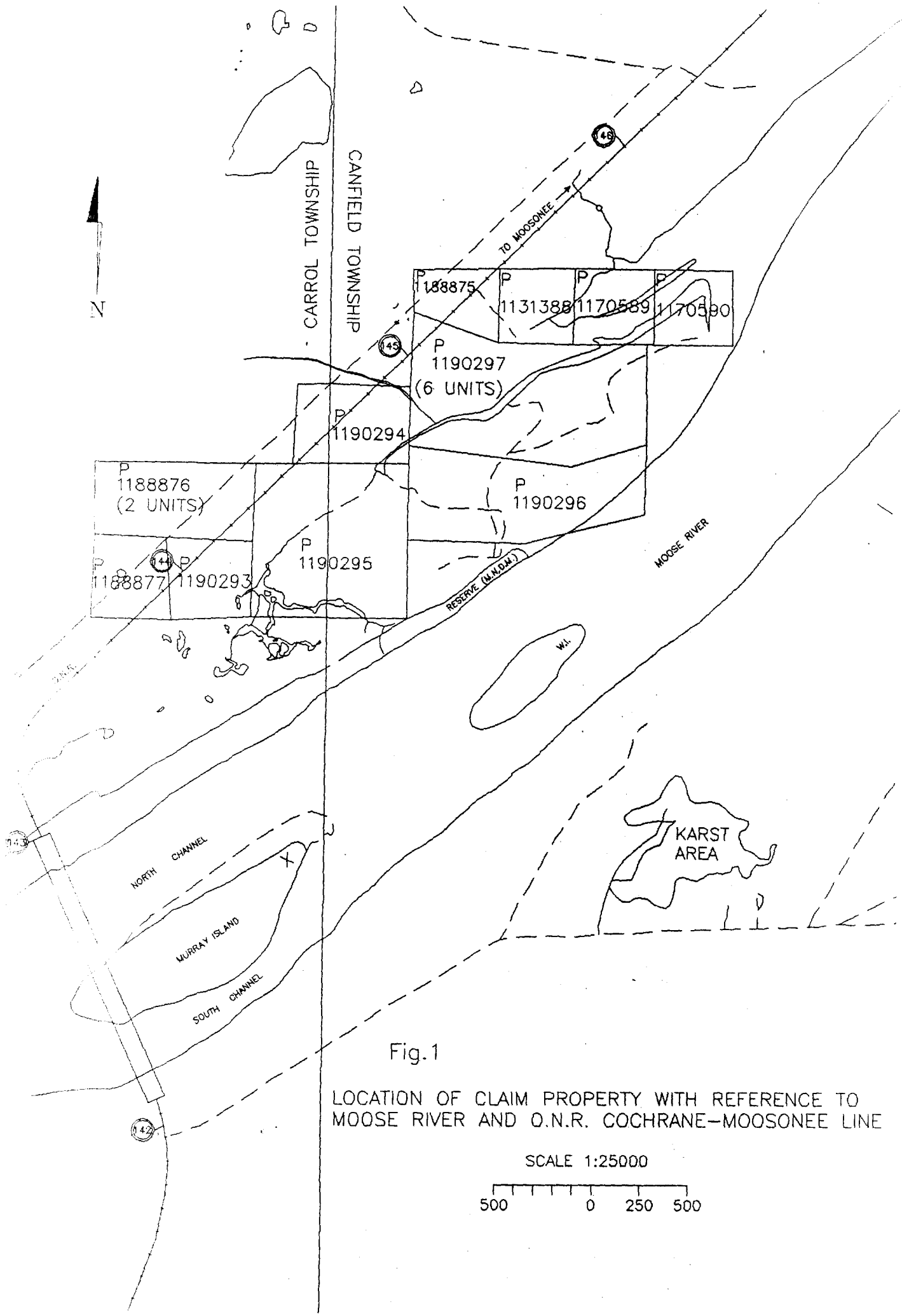

Fig.1

LOCATION OF CLAIM PROPERTY WITH REFERENCE TO MOOSE RIVER AND O.N.R. COCHRANE–MOOSONEE LINE

SCALE 1:25000

500 0 250 500

Appendix A

Direct Costs:

Wages:	Consultants		
	New World Engineering, 16 hours x $95 per hour		$ 1,520.00
		GST	$ 106.40
		Sub Total	$ 1,626.40
Laboratory Services:			
	Sample collection		$ 600.00
	Crushing and screening		$ 650.00
	Calcinating gypsum / test block production / stress testing		$ 5,600.00
		GST	$ 479.50
		Sub Total	$ 7,329.50
		TOTAL	**$ 8,955.90**

Ontario Ministry of Northern Development and Mines

Declaration of Assessment Work Performed on Mining Land

Mining Act, Subsection 65(2) and 66(3), R.S.O. 1990

Transaction Number (office use)
W9860.00012
Assessment Files Research Imaging

Personal information collected on this form is obtained under the authority of subsec
information is a public record. This information will be used to review the assessment
should be directed to a Provincial Mining Recorder, Ministry of Northern Development

42I14SW2001 2.18060 CARROLL

900

Instructions: - For work performed on Crown Lands before recor
- Please type or print in ink.

1. Recorded holder(s) (Attach a list if necessary)

Name: MARK CHARLES KEAN	Client Number: 151090
Address: P.O. BOX 2120	Telephone Number: 268-3536
TIMMINS, ON P4N 7X8	Fax Number: 268-7411
Name: KEVIN SCOTT COOL	Client Number: 120650
Address: 190 QUEEN AVE,	Telephone Number: 267-1772
TIMMINS, ON P4N 4L7	Fax Number: SAME

2. Type of work performed: Check (✓) and report on only ONE of the following groups for this declaration.

☐ Geotechnical: prospecting, surveys, assays and work under section 18 (regs) ☐ Physical: drilling stripping, trenching and associated assays ☐ Rehabilitation

Work Type: INDUSTRIAL MINERAL TESTING		Office Use
		Commodity
		Total $ Value of Work Claimed $ 8,950
Dates Work Performed From: Day 10 Month 09 Year 97 To: Day 20 Month 12 Year 97		NTS Reference
Global Positioning System Data (if available)	Township/Area: CARROLL / CANFIELD TWP	Mining Division: PORCUPINE
	M or G-Plan Number	Resident Geologist District: TIMMINS

Please remember to: - obtain a work permit from the Ministry of Natural Resources as required;
- provide proper notice to surface rights holders before starting work;
- complete and attach a Statement of Costs, form 0212;
- provide a map showing contiguous mining lands that are linked for assigning work;
- include two copies of your technical report.

3. Person or companies who prepared the technical report (Attach a list if necessary)

Name: NEW WORLDS ENGINEERING, 3234665 CANADA INC.	Telephone Number: 267-5365
Address: 68 CASTLEWOOD AVE, TIMMINS, ON P4R 1L5	Fax Number: 264-1161
Name	Telephone Number
Address	Fax Number
Name	Telephone Number
Address	Fax Number

4. Certification by Recorded Holder or Agent

I, MARK KEAN (Print Name), do hereby certify that I have personal knowledge of the facts set forth in this Declaration of Assessment Work having caused the work to be performed or witnessed the same during or after its completion and, to the best of my knowledge, the annexed report is true.

Signature of Recorded Holder or Agent		Date JAN. 12/98
Agent's Address: P.O. BOX 2120, TIMMINS ONT. P4N-7X8	Telephone Number: 705-268-3536	Fax Number: 705-268-7411

0241 (2002)

RECEIVED
JAN 12 1998
2:10 pm
PORCUPINE MINING DIVISION

RECEIVED
JAN 13 1998
GEOSCIENCE ASSESSMENT OFFICE

April 12/98

5. Work to be recorded and distributed. Work can only be assigned to claims that are contiguous (adjoining) to the mining land where work was performed, at the time work was performed. A map showing the contiguous link must accompany this form.

W9860.00012

Mining Claim Number. Or if work was done on other eligible mining land, show in this column the location number indicated on the claim map.		Number of Claim Units. For other mining land, list hectares.	Value of work performed on this claim or other mining land.	Value of work applied to this claim.	Value of work assigned to other mining claims.	Bank. Value of work to be distributed at a future date
eg	TB 7827	16 ha	$26,825	N/A	$24,000	$2,825
eg	1234567	12	0	$24,000	0	0
eg	1234568	2	$ 8,892	$ 4,000	0	$4,892
1	1190293	1		400		
2	1190294	1		400		
3	1190295	4	8,956	1,600		3356
4	1190296	2		800		
5	1190297	6		2,400		
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
	Column Totals	14	8,956	5,600	0	3356

2.18060

I, MARK KEAN (Print Full Name), do hereby certify that the above work credits are eligible under subsection 7 (1) of the Assessment Work Regulation 6/96 for assignment to contiguous claims or for application to the claim where the work was done.

Signature of Recorded Holder or Agent Authorized in Writing	Date
	JAN 12/98

6. Instructions for cutting back credits that are not approved.

Some of the credits claimed in this declaration may be cut back. Please check (✓) in the boxes below to show how you wish to prioritize the deletion of credits:

- ☐ 1. Credits are to be cut back from the Bank first, followed by option 2 or 3 or 4 as indicated.
- ☐ 2. Credits are to be cut back starting with the claims listed last, working backwards; or
- ☐ 3. Credits are to be cut back equally over all claims listed in this declaration; or
- ☐ 4. Credits are to be cut back as prioritized on the attached appendix or as follows (describe):

Note: If you have not indicated how your credits are to be deleted, credits will be cut back from the Bank first, followed by option number 2 if necessary.

For Office Use Only

Received Stamp

RECEIVED
JAN 12 1998
PORCUPINE MINING DIVISION

Deemed Approved Date	Date Notification Sent
Date Approved	Total Value of Credit Approved
Approved for Recording by Mining Recorder (Signature)	

0241 (03/97)

RECEIVED
JAN 13 1998
GEOSCIENCE ASSESSMENT OFFICE

Ontario Ministry of Northern Development and Mines

Statement of Costs for Assessment Credit

Transaction Number (office use): W9860.00012

Personal information collected on this form is obtained under the authority of subsection 6 (1) of the Assessment Work Regulation 6/96. Under section 8 of the Mining Act, this information is a public record. This information will be used to review the assessment work and correspond with the mining land holder. Questions about this collection should be directed to a Provincial Mining Recorder, Ministry of Northern Development and Mines, 3rd Floor, 933 Ramsey Lake Road, Sudbury, Ontario, P3E 6B5.

2.18060

Work Type	Units of work Depending on the type of work, list the number of hours/days worked, metres of drilling, kilometres of grid line, number of samples, etc.	Cost Per Unit of work	Total Cost
INDUSTRIAL MINERAL TEST.			8 956
Associated Costs (e.g. supplies, mobilization and demobilization).			
Transportation Costs			
Food and Lodging Costs			
		Total Value of Assessment Work	8,956

Calculations of Filing Discounts:

1. Work filed within two years of performance is claimed at 100% of the above Total Value of Assessment Work.
2. If work is filed after two years and up to five years after performance, it can only be claimed at 50% of the Total Value of Assessment Work. If this situation applies to your claims, use the calculation below:

TOTAL VALUE OF ASSESSMENT WORK x 0.50 = Total $ value of worked claimed.

Note:

- Work older than 5 years is not eligible for credit.
- A recorded holder may be required to verify expenditures claimed in this statement of costs within 45 days of a request for verification and/or correction/clarification. If verification and/or correction/clarification is not made, the Minister may reject all or part of the assessment work submitted.

Certification verifying costs:

I, MARK KEAN (please print full name), do hereby certify, that the amounts shown are as accurate as may reasonably be determined and the costs were incurred while conducting assessment work on the lands indicated on the accompanying Declaration of Work form as recorded holder / agent (recorded holder, agent, or state company position with signing authority) I am authorized to make this certification.

Signature: [signature] Date: JAN 12/98

0212 (03/97)

RECEIVED JAN 12 1998 2:10 PM PORCUPINE MINING DIVISION

RECEIVED JAN 13 GEOSCIENCE ASSESSMENT OFFICE

Ministry of
Northern Development
and Mines

Ministère du
Développement du Nord
et des Mines

Ontario

Geoscience Assessment Office
933 Ramsey Lake Road
6th Floor
Sudbury, Ontario
P3E 6B5

Telephone: (888) 415-9846
Fax: (705) 670-5881

April 17, 1998

MARK CHARLES KEAN
36 EMERALD
P.O. BOX 2120
TIMMINS,, Ontario
P4N-7X8

Dear Sir or Madam:

Submission Number: 2.18060

		Status
Subject: Transaction Number(s):	W9860.00012	Deemed Approval

We have reviewed your Assessment Work submission with the above noted Transaction Number(s). The attached summary page(s) indicate the results of the review. WE RECOMMEND YOU READ THIS SUMMARY FOR THE DETAILS PERTAINING TO YOUR ASSESSMENT WORK.

If the status for a transaction is a 45 Day Notice, the summary will outline the reasons for the notice, and any steps you can take to remedy deficiencies. The 90-day deemed approval provision, subsection 6(7) of the Assessment Work Regulation, will no longer be in effect for assessment work which has received a 45 Day Notice.

Please note any revisions must be submitted in DUPLICATE to the Geoscience Assessment Office, by the response date on the summary.

If you have any questions regarding this correspondence, please contact Steve Beneteau by e-mail at benetest@epo.gov.on.ca or by telephone at (705) 670-5855.

Yours sincerely,

ORIGINAL SIGNED BY
Blair Kite
Supervisor, Geoscience Assessment Office
Mining Lands Section

Correspondence ID: 12121

Copy for: Assessment Library

Work Report Assessment Results

Submission Number: 2.18060

Date Correspondence Sent: April 17, 1998 **Assessor:** Steve Beneteau

Transaction Number	First Claim Number	Township(s) / Area(s)	Status	Approval Date
W9860.00012	1190295	CARROLL, CANFIELD	Deemed Approval	April 12, 1998

Section:
18 Other INDUS

Note, in subsequent submissions of this nature, please ensure the sample locations are clearly indicted on 1 or more maps.

Correspondence to:

Resident Geologist
South Porcupine, ON

Assessment Files Library
Sudbury, ON

Recorded Holder(s) and/or Agent(s):

MARK CHARLES KEAN
TIMMINS,, Ontario

KEVIN SCOTT COOL
TIMMINS, Ontario

Correspondence ID: 12121