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REPORT ON

QUARRY OPERATION AT ROCK WOOL PRODUCTS QUARRY

GAP LAKE, ALTA.

by

T. H. PATCHING, P. Eng.

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11139 - 77 Ave.
Edmonton, Alta.

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Introduction

The rock quarry, operated by Rock Wool Products, Ltd., at Gap Lake, west of Exshaw, was visited by the author on September 4, 1952, in company with Mr. J. Gregory, Provincial Industrial Engineer, Mr. S. Sinclair of the University of Alberta, and Mr. A.G.Swan of the Alberta Research Council. An examination of the quarrying operations was made to determine the suitability of the present pit for supplying wool rock to the plant.

Also present to discuss the problems encountered and to provide information were Mr. J. Young, General Manager of Western Insulation, Ltd., of Vancouver, Mr. J.T.McLaren, General Manager of Rock Wool Products Ltd. of Calgary, and Mr. J.M.Cummings of Windermere who is consulting engineer for the Rock Wool Products Company.

The present operators of the plant contend that the existing quarry is unsuitable, the principal reasons given being as follows:

1 - The remaining supply of suitable wool rock is inadequate, considering the possibility of economic removal.

2 - Fluctuations in the melting characteristics of the rock from the quarry make proper operation of the furnace and blowing of wool impossible.

3 - The cost of mining material in the quarry is uneconomical because of the small scale of production caused by present furnace difficulties and the scarcity of labor to operate the plant on two or three shifts.

4 - An excessive amount of waste rock and overburden must be removed before the useable rock can be obtained, and slides and washes of overburden occur into the quarry.

5 - The present supply of flux is unsuitable.

Summary and Recommendations

1 - The composition of the rock mined from the quarry varies appreciably making furnace operation difficult, but the pattern and distribution of this variation is not known with certainty. A program of sampling and core-drilling is advisable to prove the deposit and to determine the nature and position of the future rock supply.

2 - The rock can be quarried and blended to provide a supply of suitable rock for furnace operation at a reasonable cost, but to do this facilities for blending and mixing the rock must be established and adequate fluxes provided.

3 - Steady operation at the maximum rate of output will enable lower mining costs to be obtained.

4 - The overburden can be removed in advance of mining operations without undue difficulty or expense.

5 - A suitable supply of flux should be found, but it is probably available in the district and a considerable unit cost for flux material can be justified by the small total amount required.

Quarry Location and Method of Operation

The quarry is established about 1/4 mile by road from the rock wool plant. The connecting road, although rough, steep and winding, is usable for the present haulage requirements.

The quarry has been cut into the south face of a hill at the base of the mountain, and the quarry floor is at present about 90 feet wide from east to west and about 70 feet long from north to south. The walls increase in height from the floor level at the south end to a height of about 70 feet at the north face and stand at slopes of approximately 60° - 70°. The hillside continues to rise to the north from the upper rim of the pit at a slope of about 35 to 40 degrees, so that the walls of the quarry will become higher as the quarry is extended northward. The rock is fairly strong and stands well, but for safety the walls must be maintained at a safe angle (which appears to be approximately 65 to 70 degrees) and kept scaled.

The rock is broken by drilling short steep holes with a pneumatic drill and blasting with dynamite. Fragmentation is good, with most fragments of rock being less than 12" in dimension. The broken material is moved from the face by a scraper and passed over a grizzly with rails at 1 1/2" spacing where the fine material is removed, and the oversize is then loaded as required through a chute gate into a truck for delivery to the rock wool plant.

Waste rock is removed by dumping it over the side of the hill, and ample space is available for disposing future waste material.

The rock on delivery to the plant is dumped into an open chute and there any oversize is broken by a laborer. From this chute the rock is drawn into a scale-equipped car for measurement of the furnace charge. The storage capacity developed is insufficient for flexible operation, and the charging of the furnace is inefficient. If adequate equipment were installed one man could accomplish the work that three men do now.

The scheduled yearly production of the quarry has been approximately 5000 tons or about 6-700 tons per month for a season of from early April to the end of November. Furnace requirements per shift are approximately 20 tons from which about 10 tons of rock wool are made.

At present two men working in the pit for four hours each day can supply rock for one shift per day furnace operation, i.e about 20 tons per man shift, but if no sorting of rock were required and if steady work were done in the quarry, a greater daily output per man shift could be attained. Under favorable conditions, on the basis of 25-30 tons per man shift, direct labor costs of about $0.50 and total direct costs of $1.00 per ton of rock delivered to the plant might be obtained. Removal of overburden and overhead charges, etc. would increase these costs to perhaps $1.50 per ton.

Average quarrying costs for 1951 were shown by Mr. J. Young to be $1.86 per ton, but costs for 1952 to date have been much higher because of the low tonnage produced with resultant inefficient operation and high overhead unit cost, and because of the increased tonnage of unsuitable rock that has been removed.

Stripping of overburden in advance of quarrying is necessary, but the amount is not excessive (about 10-15 feet of overburden for 75 feet of rock obtained), and its removal should present no serious difficulty or expense. It is advisable to strip at the first of the season a sufficient area to allow the years' supply of rock to be quarried without further stripping being required. This will also reduce the amount of waste washed into the pit by rains during the season. Such preliminary stripping might well be done by an earth-moving contractor.

Geology and Composition of the Rock in the Quarry

The rock mined at the quarry is a dark calcareous shale from the Banff Shale formation. The regional dip is about 30° to the west, but bedding planes are not distinct on the face of the quarry and no banding is evident across the working face. However, no local folding or faulting is apparent and it is reasonable to assume that some bedding effects exist and that some change in composition of the shale occurs from one layer to the next. It is also possible that variation of composition occurs laterally in the same layer.

The rock is massive and strong but is intersected by steeply dipping joint planes which cause it to break in blocky fragments. Calcareous material and surface material has entered these joint planes in varying amounts and formed encrustations on the shale blocks. This 'contamination' of the shale varies in degree across the face of the quarry and thus causes a local irregular variation in the analysis of the rock produced. The top 5 to 15 feet of rock is most weathered and dirty and is not desirable for making wool.

Samples of material were taken from the quarry face recently on behalf of the operating company, by Mr. J. Cummings and analysed by him for 'Loss of Weight on Ignition', which is an approximate indication of the carbonate content of the rock and thus of the acid to base ratio of the rock and hence of its slagging characteristics. The assay results were plotted on photographs and are represented in the accompanying sketch. There is no reason to question the validity of the samples, although they do not give as complete a picture of the structure as might be desired.

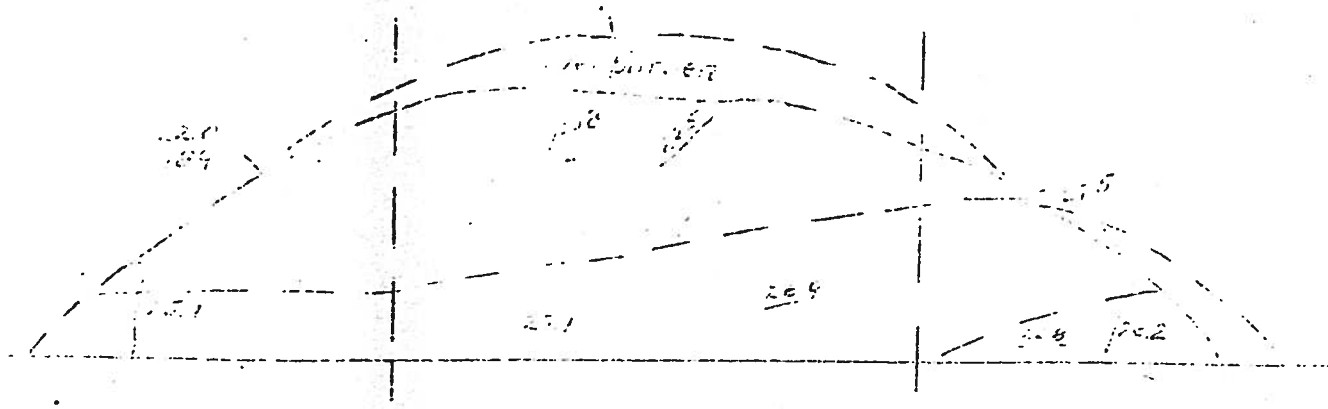
The samples show a variation in composition of rock on the face of the quarry, indicating the existence of bands of different analysis which have the same dip as the regional dip, namely about 30°.

Beneath the overburden and the weathered rock is shale having an Ignition Loss of about 20%, which is underlain by a layer of about 30 to 40 feet of shale having an I.L. of about 27%, and at the lowest section exposed is shale having an I.L. of about 23%.

To definitely prove the existence and locate the position of such bedding will require further face sampling and also a moderate amount of core drilling. About 500 to 700 feet of diamond drilling would provide valuable information on the rock to be encountered in future operations of the quarry. It is regrettable that the deposit was not proven by drilling before any quarry operations were begun, but even at this stage a drilling and sampling program is advisable as a guide to future work.

The central band of rock, having an I.L. of about 27% is considered by the management to be the preferred material for furnace operation as it is almost self fluxing and gives a good product. However, they state that they can make rock wool from almost any rock whose I.L. is within the range of 20-30% provided that they have suitable fluxes and that the grade of rock to charge into the furnace is constant. A maximum variation of about 1% between furnace charges was stated to be essential for good control. Material with a low Ignition Loss is high in silica and requires the addition of increased quantities of basic fluxes.

At present trouble is had in furnace operation because of the variation in composition of the rock feed and because of unsuitable flux materials. Attempts are being made to separate and use only the material from the 27% region of the quarry, but there is some dilution from the other material and hence a variation in the resultant feed to the furnace. If the banding interpretation of the structure from the samples is correct, it will become increasingly difficult to remove only the 27% material because of the increasing

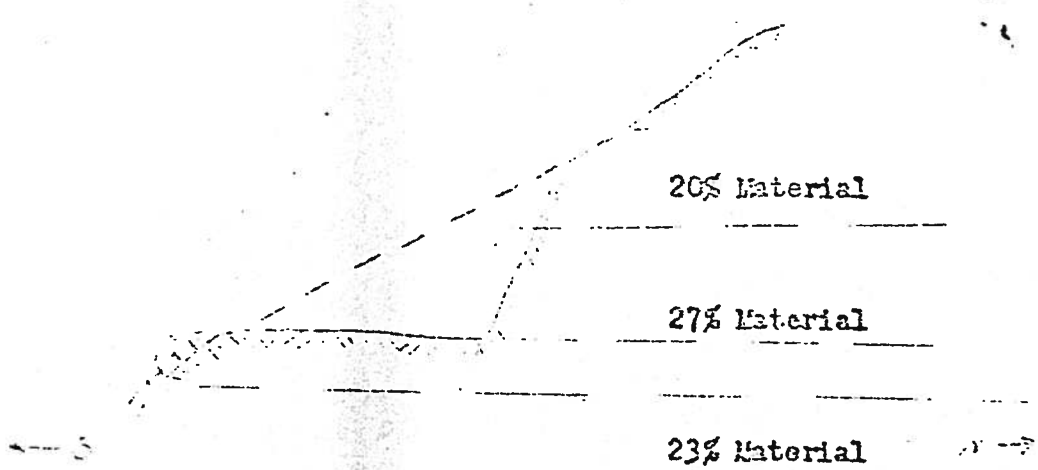


Looking N.W. Looking N. Looking N.E.

Panoramic View of Quarry Walls

Showing Sampling Results as obtained by Mr. J. Cummings

(Not to Scale !)



Constructed North - South Section through Quarry thickness of low grade covering material as the quarry is extended into the hillside (See Sketch). However this interpretation ought to be checked by drilling. If only the 27% material is to be utilized it is possible that the pit has nearly reached its economic limit, since at present an average of about 45 feet of low grade material overlie about 30 feet of 27% material, and this ratio will increase.

Alternative Measures for Obtaining Rock

Three alternative measures may be considered to extend the life of the plant:

1 - To prospect for another exposure of the desired shale in the vicinity which can be readily quarried and to open a new quarry in it. This possibility has not been investigated thoroughly.

2 - To leave the upper low grade material in place and to extract the desired layer of shale by underground mining methods. While physically possible this is not economically feasible, since underground mining is attended by many difficulties not encountered in quarry work and is more expensive, costing from about 3 to 5 times as much per ton handled, although of course only the desired rock need be handled. Rock produced by small scale underground methods cannot compete in cost with suitable material obtained by other quarry operations.

3 - To mine and blend all of the rock as exposed on the quarry face. The actual mining costs will be kept at a low figure because of the possibilities of drilling and breaking down large tonnages at one time, but some capital expenditures will be required to provide facilities for blending the rock produced. This would include installation of a small crusher to reduce the size of rock fragments to perhaps 5 or 6" diameter, and the development of storage space where the material could be mixed as it is stored and then withdrawn. Rehandling would entail some expense although it would not be great. Another

necessity would be a suitable supply of flux, since the blended material would be more siliceous and require more flux than the rock used at present.

Blending would not be perfectly accomplished because of the small size of charge to the cupola and the lumpy nature of the feed, but ought to be adequate for successful operation of the furnace. This third alternative appears to be the most favorable.

Flux Requirements

At present a dolomite flux is obtained from a small exposure several hundred yards east of the rock quarry. The dolomite is not pure and is interbedded with layers having a considerable lime content. Best fluxing action is obtained with as little lime as possible in the flux, and so the flux rock is sorted and loaded by hand. This is admittedly inefficient, and not very effective but has been justified by the small total requirements of flux. About 40 lbs. of flux are currently used per charge of 600 lbs. of wool rock having an ignition loss of about 26 or 27%, and thus only about 1 1/4 tons of flux per shift is required. If material having a lower Ignition Loss is to be used, the daily flux requirements will be increased.

Another source of flux material should be found but this will become more imperative if more siliceous wool-rock is to be used in the future. The small quantity of flux required per ton of rock used will justify a fairly high unit cost for a good flux, whether it be quarried by the company or purchased. Good flux material should be available within a reasonable distance, since there are large formations of limestones and dolomites in the district. Further prospecting and investigation is warranted to find a good supply of flux.