BUILDING STONE FROM WASTE ROCK AT OPERATING AND ABANDONED COAL MINES IN ALBERTA FOOTHILLS

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PREFACE

In February 1993, GEO-ING Resource Consulting Ltd. (GEO-ING) proposed to prospect for new sources of building stone and to investigate the abandoned Paskapoo sandstone quarries. The work was to lead to an inventory of potential building stone in Alberta. The proposal, submitted to the Canada-Alberta Agreement on Mineral Development (MDA), was not approved for funding.

In the fall of 1994 Mr. Rick Richardson of the Alberta Geological Survey (AGS), after visiting coal mines near Hinton and Grande Cache, encouraged GEO-ING to submit a modified proposal focused on the immense quantities of sandstones in the waste rock of surface coal mines in the Alberta foothills. Subsequently, the AGS commissioned GEO-ING to investigate the suitability of such sandstones as rough building stone.

Funding for the project was provided co-operatively from the Alberta Department of Energy through the AGS and the MDA through the Geological Survey of Canada.

The objective of the project was to find a workable stone and thus to identify a new resource development opportunity in Alberta. GEO-ING investigated waste rock dumps at five mines, found sources of suitable stone, tested its use, obtained bulk samples at three locations, arranged the delivery and display of the stone at building supply outlets in Edmonton and Calgary, and consulted stonemasons about the use of the various stone types. Results of the project are presented in this report.
ACKNOWLEDGEMENTS

Without the support of Rick Richardson of the AGS the project would not have proceeded.

Dale Fietz of ELAD Enterprises Inc. provided a liaison between the AGS and GEO-ING.

Roger Mandel and Boris Vyskocil assisted in loading pallets with over 20 tonnes of sandstone.

Ron Kostiuk and Kevin Morris organized the shipment of a bulk sample of sandstone from the Smoky River Mine; Ron Parent and Astrid Art helped to ship the bulk sample from the Gregg River Mine.
DEFINITIONS OF TERMS

Several terms used in this report require definition. While the subject is ordinary rock, it will be referred to by different words that reflect its end use.

Rock: Solid part of earth’s crust underlying soil (Oxford Dictionary of Current English). In this report the term is used in a general sense, usually when the end use is uncertain or irrelevant.

Overburden: In surface coal mines it is the consolidated and unconsolidated material (rock, gravel and soil) overlying a mineable coal seam.

Waste rock: Rock excavated from the overburden.

Waste rock dump: The site of deposition of waste rock.

Stone: In general, a piece of rock of any shape (Oxford Dictionary of Current English). In a commercial sense (and in this report), the term refers to rock judged to have a potential use as a decorative or structural material in construction, landscaping, sculpture or in other industrial applications.

It encompasses materials ranging from crushed stone for landscaping or road building to polished marble, granite and other rock veneers. In this report, a distinction is maintained between natural and less processed building stone and more processed, often cut and polished dimension stone.

Building stone: Stone used in construction, either as structural or decorative material, in its natural, little modified form. It ranges from rock boulders to more or less evenly shaped pieces of naturally layered rock. Building stone is subject to no or minimum processing. Rough building stone or rubble is stone of irregular shape.

Dimension stone: Stone that has been processed to desired dimensions, shape and finish. It
includes stone ranging from dressed, regularly shaped stone blocks either massive (for structural support) or thin cut slabs (veneer) to monument blocks and cut, thin stone panels or tiles with finished (textured or polished) surface.

Flagstone: Slabby rough stone ranging in thickness from 2 to 7 cm.
SUMMARY

Field investigations, which took place during July, August and early September, 1995, located four potential sources of building stone at coal mining sites in the Alberta foothills. One location is an abandoned mine and three are active coal mines. In all cases the potentially useful rock is sandstone.

As an aid in identifying and marketing the sandstones, they have been given names reflecting their potential quarry locations.

Sandstone from the Smoky River Mine, approximately 20 km north of the town of Grande Cache, appears to be the most promising. This rock has been named Smokystone and is found along the footwall of Pit No. 3 in No. 12 Mine West operated by Smoky River Coal Ltd. Mining in this pit was completed in 1993 and the area currently is being reclaimed. Recovery of this stone for building purposes could commence as soon as reclamation is completed. It is estimated that this will occur sometime in 1996. Smokystone is a medium grey to dark grey, siliceous, very fine grained slabby to flaggy (5 cm and 10 cm thick) sandstone. The colour of the stone is medium to dark grey on fresh surfaces with yellow and white coloration along joint surfaces. The bedding planes (i.e., the top and bottom) are greyish black to black. In general appearance it is similar to Rundlestone which is quarried in the Bow Corridor and used extensively as decorative facing in the Canmore-Banff area and elsewhere in Alberta. Two pallets of Smokystone were shipped to Angelo Building Supplies Ltd. in Edmonton to expose the stone to potential customers. Masons who saw the stone were pleased with its shape and colour, but concerned with the carbon dusting on its flat sides. About one half tonne of the stone was sold for building a low retaining drywall in a garden. At the sample site there is a reserve of about 800 m³ of the stone and elsewhere in the pit there is excellent potential for a substantial increase of this quantity.

The Town Council of the town of Grande Cache was interested in having Smokystone installed as facing on the lower part of the front wall of the Tourism Centre that was under construction in September 1995. The council did not have enough money to pay for stone installation, an estimated cost of about $17000. Since stucco was used on the wall, there remains a possibility to replace it with Smokystone in the future.
In the Gregg River Mine, 40 km southeast of Hinton, an outcrop of the Torrens Member sandstone was investigated. The rock at this site was bulk sampled and named Greggstone. It is hard, slightly calcareous, medium to coarse grained quartz sandstone. At the outcrop the colour of the partially weathered stone is ochre-grey to greyish-light brown. When fresh, it is an even bluish-grey. Slabby and flaggy stone ranging in thickness from 3 to 15 cm is available from this site. The outcrop is located at the southern end of Pit No. H4-East and is adjacent to one of the main mine roads. It could be developed as a hill-side quarry. Exploitation of this site may have to be delayed until mine activities in the vicinity have ceased. One pallet of Greggstone has been on display at Angelo Building Supplies Ltd. in Edmonton since early August. Positive comments were expressed by several masons but there has been no demand for this stone to date. The potential quarry contains a reserve of at least 6000 m³.

The third stone, named Lillestone, is rubble from an old rock dump at the abandoned Grassy Mountain open pit coal mine 8 km north of Blairmore in the Crowsnest Pass. This stone is a hard, medium to coarse grained, siliceous sandstone. When weathered, it is an attractive light grey to greyish-brown to orange brown stone. The rock breaks into pieces of generally polygonal shape and thus is rather more difficult to work with than the popular slabby and flaggy stone. Four pallets of Lillestone have been on display at Alomar Building Products in Calgary since late July. Several masons looked at the stone with interest but appear to have been discouraged with its irregular shape, which increases the labour cost of installation. The dump at Grassy Mountain contains approximately 1750 m³ of stone.

The fourth stone is similar to Greggstone but has not been named as exploitation is unlikely. It too is from an outcrop of the Torrens Member sandstone. The outcrop is a nearly vertical rock wall located at the southeastern end of No. 12 Mine West operated by Smoky River Coal Ltd., in the same general area where Smokystone was found. The site is adjacent to the access road to Smokystone. Exploitation, or even bulk sampling of this stone, would require blasting down the whole 30 m high outcrop. Such action would at least temporarily prevent access to mine reclamation operations in No. 12 Mine West area as well as to deposits of Smokystone.
INTRODUCTION

General background

At the beginning of this century Alberta had a viable building stone industry supported by twenty one stone quarries (Parks, 1916). The principal stone was Paskapoo Sandstone which was used extensively in a number of government buildings in Alberta’s major cities and larger towns. Many of these buildings are an important part of Alberta’s architectural heritage but no sandstone is currently quarried for modern building. When Paskapoo sandstone of good quality was found a few years ago in excavations for residential development around Calgary, some of it was saved and used in restoration of several historic buildings (Photograph 1). More frequently, weathered boulders of the same stone are used in landscaping.

In the Alberta foothills, where rock outcrops were accessible, various rocks were used as building stone. Construction ranged from curbs and retaining walls to large structures.

In the Crowsnest Pass, local sandstones were used in the past. The ruins of Leitch Collieries near Burmis (Photograph 2.1 and 2.2) are built of Belly River Formation sandstone. In the long abandoned mining town of Lille the basal Kootenay Group sandstone (Moose Mountain Member of the Morrissey Formation) was used (Photograph 3). No building stone is quarried in the Crowsnest Pass today but a considerable quantity of the basal Kootenay Group sandstone can be found in the waste rock piles on Grassy Mountain located a short distance north of Lille, or 8 km north of Blairmore. The stone from Grassy Mountain is addressed in this report.

In Waterton National Park a small quarry of Waterton Formation argillite supplied a building stone used mainly as facing for a number of buildings (Photographs 4.1 and 4.2).

In the Canmore-Banff corridor, Rundlestone, a grey calcareous siltstone from the Triassic Spray River Group has been used since the turn of the century, and its use continues today. The stone decorates many buildings and structures in Alberta (Photograph 5). One of the most recent applications is on the exterior of a large new hotel at the Columbia Icefield in Jasper National Park. It has also been exported to Japan to decorate a new home built by a Canadian company. A source of stone quite similar to Rundlestone is present in one of the mined out open pits in the Smoky River Mine, located north of Grande Cache. It has been named Smokystone and it is described in this report.
In Jasper, a greyish pink quartzite from the St. Piran Formation has been used on a number of buildings (Photograph 6.1 and 6.2). The stone is found in an avalanche area at Poboktan-Jonas Creeks, Jasper National Park (Godfrey, 1986). It is probably Alberta’s most attractive building stone; unfortunately, it is found only in the National Park and is not commercially available.

Elsewhere in the foothills very little local stone has been used. Even in Hinton and Grande Cache where a practically unlimited quantity of sandstone can be picked from the waste rock in the nearby coal mines, no local stone is used.

**Sandstone in the waste rock of surface coal mines**

Mining operations at surface coal mines necessitate the removal of overburden consisting of shales, siltstones and sandstones to gain access to the underlying coal. Once excavated the overburden becomes waste rock which is hauled away from the open pit areas to nearby rock dumps (Photograph 7) or used to backfill previously mined out pits. The volume of waste rock is several times greater than the tonnage of coal produced. Tens of millions of cubic metres of rock are excavated annually. Sandstone ranges from less than 50% to 100% of the waste rock at Alberta coal mines.

**Locations investigated**

Sandstones in waste rock sites were investigated at the following areas and mines:

- **Crowsnest Pass:** Adanac (abandoned mine)
  Grassy Mountain (abandoned mine)

- **Hinton:** The Gregg River Mine operated by Gregg River Coal Ltd.
  The Luscar Mine operated by Cardinal River Coals Ltd.

- **Grande Cache:** The Smoky River Mine operated by Smoky River Coal Ltd.
Locations sampled

Bulk samples, in the form of 2 tonne pallets, were collected at the following locations:

- Grassy Mountain; 4 pallets shipped to Calgary
- Gregg River Mine; 1 pallet shipped to Edmonton
- Smoky River Mine; 2 pallets shipped to Edmonton
- 4 pallets remain at the site

The sampled locations are shown in Figure 1.
Figure 1. Index map showing locations of investigated mine sites.
Stratigraphic setting

In all cases the rock at the investigated sites belongs to Lower Cretaceous formations. At Grassy Mountain the waste rock comes from the Mist Mountain and Morrissey formations of the Kootenay Group. At the Gregg River, Luscar and Smoky River Mines it comes from strata of the Torrens and Grande Cache Members of the Gates Formation of the Luscar Group (Figure 2).

Figure 2. Stratigraphic nomenclature of Lower Cretaceous formations in Crowsnest Pass Area (after Gibson, 1985); and in Hinton and Grande Cache Areas (after Langenberg and McMenemy, 1985).
DESCRIPTION OF WASTE ROCK SITES AND USABLE STONE

This report is the result of investigations concerning the usefulness, as building stone, of sandstones dumped or exposed at the mines listed on page 2. It includes a brief introduction to each area, outlines the nature of the rock in waste rock dumps or outcrops, describes in detail each sandstone that is judged useful as building stone, identifies the location from which the bulk sample was taken and provides a preliminary estimate of minimum reserves of the stone. A set of photographs in Appendix 1 illustrates the information provided in the text. Data sheets in Appendix 2 summarize the basic data on each stone and its deposit. Specimen samples of various stones were provided to the AGS for future reference and the author kept a second set of samples.

CROWSNEST PASS

In the mining towns of the Crowsnest Pass local sandstone has been used in construction ranging from buildings to retaining walls. More extensive work dates back to the early part of this century. At the east entrance to the Crowsnest Pass, near Burmis, the remains of buildings built by Leitch Collieries in 1907 are the largest stone structures in the Pass. To build the power house (Photograph 2.1) and the mine manager’s residence (Photograph 2.2), Belly River Formation sandstone was used as a structural material. It has the appeal of natural stone and a feeling of strength, much like stone facings used on many modern buildings today.

The ruins of the hotel in the long-abandoned coal mining town of Lille (Photograph 3), located 8 km north of the village of Frank, exhibit the usefulness of the basal Kootenay Group sandstone (Moose Mountain Member of the Morrissey Formation) as a building stone. The same stone was used to face a residential driveway entrance built in Calgary in 1983 (Photograph 8).

There are several abandoned surface coal mines in the Municipality of Crowsnest Pass. The overburden in these mines included shales, siltstones and sandstones of the Mist Mountain Formation and, depending on the location of the mine, lesser or larger amounts of Cadomin Conglomerate. Occasionally the sandstone of the Moose Mountain Member of the Morrissey Formation (the basal Kootenay Group sandstone) was also excavated or exposed. Mines investigated for the purpose of this report are Adanac and Grassy Mountain.
Adanac

There are three open pits in the Adanac area, 10 km south of the village of Hillcrest. No suitable sandstone was found. There is a considerable amount of conglomerate blocks which could be used as riprap rock. If a larger quantity were required it would have to be blasted from the pit highwall. Although there is conglomerate in the waste rock dumps, it is not accessible. The main access road to the mines is seriously deteriorated.

Grassy Mountain

Grassy Mountain is an abandoned complex of ten open pits, located 8 km north of the town of Blairmore. Except for the southern most five pits and adjacent dumps, the area is not accessible to vehicles. The road leading to the top of the mountain has been washed out.

The waste rock on the dumps is a mixture of mudstone, shale, siltstone and sandstones of the Mist Mountain Formation, a minor amount of conglomerate of the Cadomin Formation and a lesser amount of Moose Mountain sandstone. The sandstones from the Mist Mountain Formation are variably carbonaceous and tend to break down (Photograph 9). They are generally not suitable as building stone. At the foot of the mountain on one of the accessible dumps a concentration of the Moose Mountain sandstone is present. This rock is a good candidate for use as a rough building stone. It was named Lillestone.

Four pallets, approximately eight tonnes of Lillestone, were collected from the base of this dump.

Sample site

This waste rock dump (Photographs 10.1 and 10.2) from which the four pallet sample was collected is located in Lsd 4, Sec 25, Twp 8, Rge 4 W5M. The site is approximately 400 m west from the main access road and 60 m east of the southern end of Pit No.5 that runs from south to north in Section 25. Most of the rock on the dump is Moose Mountain Member sandstone. It probably was excavated some 40 years ago.
Lillestone

The stone is a hard, medium to coarse-grained, siliceous sandstone. It consists mainly of quartz and chert. On a fresh surface it is light to medium grey. Some weathered surfaces are light grey to greyish-brown, some are orange brown to rusty brown and occasionally it is mottled grey and brown in colour. The shape of individual pieces and blocks is polygonal resulting from the breakdown along the multidirectional joints and original bedding. Although the stone pieces are generally irregular each has a planar side that will provide the finished surface when used. A stone wall can be faced with this stone (Photograph 11) but not as easily as with flagstone or rough veneer stone. Dressing the stone results in a fresh grey surface contrasting with the predominantly light brown and rusty colour of the weathered stone. The size of stone pieces on the dump is variable, ranging from fairly small fragments (less than 10 cm) to boulders and blocks larger than 50 cm. Medium-size stone, 8-10 x 25-30 x 12-15 cm, is common.

Lillestone is suitable for mortared, rough stone construction where only a limited amount of dressing is required. Compared to work with more slabby stone, it would be more time-consuming, but a skilled stonemason could easily build with this stone. The stone could also be used locally to build dry (unmortared) retaining walls or stonewalls similar to those shown in Photographs 12.1, 12.2 and 12.3. For such usage the stone could be quite inexpensive if loaded in bulk and hauled short distances.

In the Crowsnest Pass the sandstone from Grassy Mountain could become a locally used rough building stone similar to the river cobbles and boulders used for building decorative structures in the Radium Hot Springs - Fairmont area of British Columbia.

Bulk Sample

Four pallets of Lillestone (Photograph 13) were shipped to Alomar Building Products in Calgary. Three pallets were stacked with stone ranging from 20 to 40 cm and one pallet was stacked with larger blocks of stone (over 40 cm). At the time of writing the stone has been on display in Alomar's yard for 3 months. Stone masons who looked at it felt the stone could be used but, because of its irregular shape, it is unlikely to be in significant demand.
Exploitation

Lillestone can be loaded in bulk for local delivery or picked by hand according to size and loaded on pallets for shipping to more distant markets. The stone utilization, based on experience in facing the entrance gate in Calgary (Photographs 8 and 11), was approximately 85-90%. The stone was hand picked from a small dump in Bellevue, Crowsnest Pass, with limited concern for size and grade.

Reserves

The area of the sampled waste rock dump is about 2400 m². The depth of the dump was not measured. Assuming an average depth of the layer of sandstone boulders to be about 1.5 m, and allowing 30% for airspace between the rocks, the volume of stone at the sampled site would be 2500 m³ of sandstone. Assuming that 70% of it could be used, there is a reserve of some 1750 m³ of rough building stone.
HINTON AREA

There are four active and two abandoned surface coal mines in the Hinton area. The waste rock dumps were examined in the mines of Cardinal River Coals Ltd. and Gregg River Resources Ltd. At these mines the overburden contains sandstones belonging to the Gates Formation of the Luscar Group. The volume of excavated overburden at both mines is over 10 million m³ annually. It is a mixture of sandstone, argillaceous sandstone, siltstone, mudstone and shale, in which sandstone predominates. Most of the sandstone is irregularly shaped, similar to the Lillestone from Grassy Mountain. Because masons’ response to the shape of Lillestone was unfavorable, the search in the Hinton area was directed to more regular, slabby stone. Sandstone of such nature was found near Pit No. H4-East in the Gregg River Mine area.

Gregg River Mine

The mine is a surface coal mining complex, located 28 km southeast of Hinton. The preferred, slabby sandstone is present in the upper part of the Torrens Member which is frequently exposed throughout the mine area. One pallet of this sandstone (Photograph 14) was loaded and shipped to Angelo Building Supplies Ltd. in Edmonton. It was named Greggstone.

Sample site

Greggstone was sampled from a road cut (Photograph 15) located at the southern end of Pit No. H4-East in Lsd 5, Sec 31, Twp 47, Rge 24 W5M and adjacent to one of the main mine roads. The interval of interest is the upper 8 m of the outcrop. It dips 35° to the southwest.

Greggstone

This stone is a hard, argillaceous, slightly calcareous, medium to coarse-grained, quartz sandstone, with a moderate amount of carbon particles. It is grey when fresh, and ochre-grey to greyish light brown when weathered; the overall colour of this rock is greyish light brown.

Within the 8 m thick interval, the sandstone separates along bedding planes providing flagstone
material 3-12 cm thick (Photograph 16.1). The secondary separation is along joints. Spacing of joints ranges from 5-20 cm to 30-40 cm (Photograph 16.2). The wider joints result in the most useful blocky stone. The closer joints often produce a needle-like stone (Photograph 17.1). In the mid-section of the outcrop, a 1 m thick interval, the stone separates along bedding into 3-8 cm thick flagstone. The same bed near the surface (0.7-1 m interval below the soil-bedrock contact) contains flagstone 2-6 cm thick (Photograph 17.2).

Reserves

The layer of interest is located on a hillside in a dipslope configuration. It is 15 m wide at the front side of the outcrop and can be excavated for at least 50 m along the strike. With a thickness of 8 m, the interval contains 6000 m$^3$ of sandstone, that could be developed as a hillside quarry. A backhoe could excavate the stone in the shallow, partially weathered part of the deposit. While sampling the front of the outcrop, the stone was easily released with a crowbar (Photograph 18).

Luscar Mine

The Luscar Mine is an open pit complex operated by Cardinal River Coals Ltd. It is adjacent to the Gregg River Mine. A potentially useful sandstone was found on an active dump located across the railway and the Hinton-Cadomin road. The sandstone, deserving more attention, is hard, generally light brown, coarse grained and blocky. It appears to be the Torrens Member sandstone, but this has yet to be confirmed. The waste dump of this sandstone is shown in Photograph 19.
GRANDE CACHE

There is only one coal mining operation in the Grande Cache area. It is the Smoky River Mine, an underground and open pit mining complex.

Smoky River Mine

Smoky River Coal Ltd. (SRCL) operates surface and underground coal mines in the Sheep Creek valley, 20 km north of the town of Grande Cache. Underground mining began in 1970 and the first surface mine opened in 1971. Since then, a series of open pits have been started, mined out, backfilled to various degrees, reclaimed and closed. One of the results of surface mining is extensive waste rock dumps containing tens of millions of cubic metres of overburden rock. Most of this rock belongs to the Grande Cache Member of the Gates Formation. Occasionally, the sandstone of the Torrens Member is exposed in the pit or along the roads.

The bulk of the waste rock is sandstone, especially in the active mining areas, including the latest surface mine (No. 12 Mine area). In the older dumps (No. 9 Mine area), it is more a mixture of sandstone, siltstone and mudstone. In general, the sandstone fragments are of irregular shape and size. Both relatively solid rock and rock that breaks down easily are present. The sandstone on older dumps is more attractive. Weathering has changed the sandstone, that was initially mainly grey, into a rock of three colour categories: light to medium grey, beige-grey to light brown and greyish-red to rusty-red. There is also an attractive two-coloured, grey and purple stone which is hard and solid, but irregularly shaped. The stone is light grey to olive grey when fresh. To illustrate the use of this stone for rough construction, a drystone mini-wall of the two-coloured stone (Photograph 20.1) was erected.

In general, the sandstone on waste rock dumps in the Smoky River Mine area is not as good as the stone sampled at Grassy Mountain in the Crowsnest Pass. Nevertheless, there is plenty of material for local rough stone construction; probably more suitable to a do-it-yourself person than for commercial purposes. To obtain useful material, the suitable stone must be selectively hand-picked to avoid disintegrating rock and to choose the more regularly shaped pieces. Efficient loading of stone on pallets for commercial purposes from the waste rock dumps is unlikely. Photograph 20.2 shows part of an older dump in the No. 9 Mine area.
No. 12 Mine West

In the No. 12 Mine West area, sandstone with very good potential for use as a building stone occurs at two locations. The first one is a steep outcrop of the Torrens sandstone (Photograph 21.1) located in Lsd 12, Sec 22, Twp 58, Rge 9 W6M, 50 m north of the turnoff to No. 12 Mine West from the road leading to No. 11 Mine. The second site is a layer of sandstone on the footwall of the mined-out pit No. 3 located in Lsd 3, Sec 28, Twp 58, Rge 9 W6M. The footwall sandstone has been designated as the Bench Sandstone by SRCL engineers. Sandstone from the upper part of this unit is, by far, the best stone found in the Smoky River Mine area.

Torrens Sandstone

The interval of interest is in the upper part of the Torrens Member sandstone. It is 5-6 m thick, of which the 2 metre thick middle part provides the most evenly bedded, slabby stone (Photograph 21.2). Depending on the degree of oxidization, this stone ranges in colour from medium grey to brownish-grey to ochre-grey. It is evenly grey when fresh. The stone is a hard, coarse-grained, quartz and chert, salt & pepper, slightly carbonaceous sandstone. Bedding of the exposure is nearly vertical; a large quantity of stone could be released by a light blast at the base.

Bench Sandstone

The Bench Sandstone is an 8 m interval with two sandstone beds located 3 m below the main coal seam (No. 4). It is exposed only when it is necessary to ensure the stability of a steep footwall of the pit, as is evident in all the pits in No. 12 Mine West. The unit of interest is the uppermost 1 m thick layer of thin to medium bedded sandstones, interbedded with thin carbonaceous shales. Thicknesses of individual layers of sandstone range from 3-20 cm (Photographs 22.1 and 22.2). A pile of sandstone slabs from the upper part of the Bench Sandstone is shown in Photographs 23.1 and 23.2. Flaggy sandstone present among these slabs is the best, readily available stone from the Smoky River Mine area. It was named Smokystone.
Smokystone

Smokystone is a medium dark to dark grey, very fine-grained, non-calcareous, siliceous, flaggy sandstone. The top and bottom sides of the stone are greyish-black to black due to the presence of carbonaceous to coaly material on the bedding planes. The flat side of the stone varies from dull to glossy black. Frequently, one of the bedding planes has well defined gentle ripple marks that give the flat part of the stone a very interesting textural feature. The best stone comes from the bottom and the top parts of the 100-120 cm thick Bench Sandstone. Thick slabs often separate into two grades of thickness: the ‘2 inch stone’ ranging from 4-6 cm, and the ‘4 inch stone’ typically 10 cm thick. The large slabs break down along well defined joints into 10 by 15 cm to 40 by 60 cm pieces (Photograph 24.1). The joints are up to 2 mm wide and are healed with a cream-white yellow weathering dolomitic siderite (Photograph 24.2). Some stones break along closely spaced parallel joints and form stone needles (e.g. 6 cm thick, 15-25 cm wide, and 80 cm long).

Bulk Sample

Smokystone was sampled from a pile of rock that slid down from the 35° pit footwall. The pile includes three kinds of stone: the Smokystone and two other types of stone considered inferior because of their contamination with carbonaceous shale. Two pallets with about 4 tonnes of Smokystone were loaded and shipped to Angelo Building Supplies Ltd. in Edmonton (Photograph 25). One pallet (1.1 x 1.1 x 1 m) was loaded with 6 cm thick stone; slab dimensions ranged from 10 x 15 to 40 x 60 cm. The second pallet (1.2 x 1.2 x 1 m) was loaded with 8-10 cm thick stone; slab dimensions ranged from 10 x 20 to 30 x 50 cm. The stacked stone on the pallets shows the grey colour of the stone broken through its body (across the joints) and the yellow or white colour when broken along the weathered or unweathered joints (Photograph 25).

Four additional pallets were loaded later when an opportunity to use the stone commercially developed in Edmonton. Unfortunately this opportunity did not materialize.

Use of Smokystone

Smokystone is very similar to Rundlestone both in colour and shape. Rundlestone has been used
extensively in Banff, Canmore, Calgary and elsewhere primarily as a facing stone (Photograph 26), often as a paving flagstone, or as stone for curb walls and retaining walls. Photograph 27.1 is an example of a mortared Rundlestone facing and Photograph 27.2 shows drypack facing. The stone is used in exterior as well as interior applications. Recently, large Rundlestone blocks have been used in landscaping (Photograph 28). Smokystone (Photograph 29) could be used in any of the examples shown. Large to very large slabs (80 x 50 cm and larger) are commonly available and could be an excellent material for spacious flagstone floors. It is expected that, due to its iron content, the stone will weather slightly reddish. Smokystone was offered to the Town of Grande Cache when the Grande Cache Tourism Centre was being build in August and September, 1995. The plan of the centre called for a stone facing on the lower three feet of the front wall and on six columns supporting an extended roof. While this would have been an ideal opportunity for the first time application of the stone the budget for the building allowed only $5000 for stone installation. Installation was quoted to be $17000. Stucco was used instead.

Exploitation

The upper part of the Bench Sandstone, within which the Smokystone is present, can be released from the inclined 30 m high pit footwall by:

Blasting. This would be very expedient but undesirable because it makes the stone more brittle. The stone was already exposed to blasting during the overburden removal and any additional shock should be avoided.

Backhoe. An excavator with a long reach is probably an ideal machine. However, it would damage some stone and dilution of the best stone with inferior rock may not be avoidable.

Manual. Stone release this way could prove to be very efficient since dilution would be minimal. It certainly should be tried. The work would require a man to be secured by a lifeline from the bench above the pitwall to work with an air pick to release the sandstone layer by layer, to cause it to slide to the floor of the pit. Any unwanted rock could be pushed away with a dozer, and the best stone, when released, would come down uncontaminated. This may be the best way to release the stone but its acceptability to mining inspectors would have to be determined.
Reserves

The sloping pit footwall is 30 m wide. In the vicinity of the sample site and further in the pit along the strike, there is at least 100-150 m of the same stone. If only the best layer of sandstone (15-20 cm thick) is considered, then at least 800 m$^3$ of stone is available. However, further investigation of adjacent Pit No. 5 and Pit No. 4 should increase reserves considerably.

Workability

The thickness of the stone is moderately consistent, within a range of a several centimetres from the average. The surface is fairly even but not smooth. This will allow comfortable and efficient placing of the stone when used with mortar similar to the application in Photograph 27.1. A tight, rustic drypack wall (Photograph 27.2) is possible.

The stone breaks easily along joints with a light blow from a 1.5 kg hammer. When breaking a larger piece of stone across the direction of joints, the break may be crooked and uneven making the broken smaller pieces less usable. Using a brick splitter results in an even and smooth break most of the time. Minor dressing of edges and adjustments of shape are easy.

Economics

Since Smokystone and Rundlestone are similar, the price of Rundlestone is the ceiling price for Smokystone. The same probably applies to Greggstone.

Thunderstone Quarries Ltd., operator of the Rundlestone quarry, quoted the following prices for their stone graded and stacked on pallets at the quarry:

<table>
<thead>
<tr>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch stone</td>
<td>$ 95/t</td>
</tr>
<tr>
<td>2 inch stone</td>
<td>$ 165/t</td>
</tr>
<tr>
<td>1 inch stone</td>
<td>$ 315/t</td>
</tr>
<tr>
<td>and</td>
<td></td>
</tr>
<tr>
<td>pit-run (bulk stone)</td>
<td>$ 80-85/t</td>
</tr>
</tbody>
</table>
A stone supplier in Edmonton claims that he can purchase Rundlestone, including delivery to his Edmonton storage yard, at the same prices as listed above. The quote for shipping 20 tonnes of Smokystone from the mine site to Edmonton was $700 per load (i.e., $35/t).

To be competitive the FOB price of the 4 inch Smokystone must be less than $60/t. This must pay for release of the stone (backhoe or manual), labour cost of stacking the stone on pallets, administration, marketing and profit. The experience from loading the pallets when preparing the bulk sample indicates that this will be a critical cost item. Unless the pile of rock can be better organized picking the right stone (which is about 1/3 of the pile) and stacking the pallets would take too long (as it did when sampling) and the stone would not be economical.

In the market place, domestic rough building stone competes with bricks, imported stone of similar kind and with imitation stone.

Comparative prices of these materials used as decorative wall facing or as paving are presented below:

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost of wall facing ($/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick</td>
<td>$35</td>
</tr>
<tr>
<td>Rough stone veneer (1&quot; stone)</td>
<td>$30</td>
</tr>
<tr>
<td>Imitation stone</td>
<td>$90-120</td>
</tr>
<tr>
<td>Rough stone, mortared</td>
<td>$105</td>
</tr>
<tr>
<td>Rough stone, drypack</td>
<td>$130</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost of paving ($/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interlocking bricks</td>
<td>$21</td>
</tr>
<tr>
<td>Flagstone</td>
<td>$30</td>
</tr>
</tbody>
</table>

It is obvious that stone is in its own price category. When used as facing it is at least three times more expensive than brick which provides a similar result. The customer who selects stone makes a decision based not on utilitarian but rather aesthetic reasons. It should be noted that the consumption of both dimension stone and rough building stone has increased in the past two decades.

Alberta production of Rundlestone, by Thunderstone Quarries Ltd. and Rundle Rock Building Stone (1980) Ltd., remains nearly constant at about 100,000 tonnes per year (Scafe, 1995). At a
conservative $95/t, the annual value of this stone is approximately $9.5 million. In addition to Rundlestone, Alberta imports, mainly from the United States, rough stone and flagstone valued (in 1995) at $375,000 (Statistics Canada, Advisory Services).
REFERENCES


APPENDIX 1.

PHOTOGRAPHS
1. South wall of Grace Presbyterian Church built of Paskapoo Sandstone in 1913.

The sandstone walls of this church were recently restored by Jensen I.B. Masonry of Calgary. Note the fresh buff colour of the stone and the replaced, perfectly blended stone in cornice in the middle of the building’s corner opposite of the leaded window.
2.1 Leitch Collieries power house, near Burmis, Crowsnest Pass;

2.2 Leitch Collieries mine manager’s residence; same location.

Both structures were built of Belly River Sandstone from a quarry located a short distance to the NE. The rockwork was stabilized in 1982-83.
3. Ruins of hotel in Lille, Crowsnest Pass;

These walls were constructed c. 1904 from the Kootenay basal sandstone (Moose Mountain Member of the Morrissey Formation). This particular rock has been named Lillestone in this report. Note that the stone has been crudely dressed into ashlar-like blocks.
4.1 A quarry of Waterton Formation argillite located along the Cameron Lake road in Waterton National Park.

4.2 East entrance of the Waterton National Park faced with Waterton Formation argillite from the quarry above.
5. Entrance structure at Arbour Lake subdivision in NW Calgary; Excellent use of variable sized Rundlestone.
6.1 St. Piran quartzite on the front wall of Whistlers Inn in Jasper.

6.2 A wall in Jasper faced with St. Piran quartzite dressed as ashlar.

Note similarity of stone work, most likely done by the same mason. The stone comes from an avalanche area located in Jasper National Park.

This is an active dump with fresh rock of the Gates Formation. Note the typical colour of unweathered sandstone boulders ranging from dark to light gray. Dark gray mudstone and shale is also visible.
8. Gatepost at a country residence, west of Calgary.

Concrete block structure with facing of Lillestone collected in Crowsnest Pass. Constructed in 1983.
9. Mist Mountain Formation sandstone and shale on an old waste rock dump at Grassy Mountain.

Note the mixture of rocks and breakdown of sandstone pieces to the right of the hammer. The two pieces of solid sandstone to the left of the hammer could be used as building stone.
10.1 Waste rock dump at lower Grassy Mountain area in Crowsnest Pass.

10.2 Close-up of above rock dump with Lillestone. Note rock colours and shapes.

Hard, siliceous sandstone of attractive colour range. This material has been named Lillestone.
11. Rough stone facing with Lillestone
12.1 Drystone retaining wall of rough stone; Radium Hot Springs, B.C.

12.2 Drystone retaining wall built of rough stone; Victoria, B.C.

12.3 Drystone wall built of rough basalt in St.Helena, California

Very rough, variable sized stone has been used in the above examples. The top and bottom walls contain no mortar. The middle wall probably does. Lillestone would be suitable material to built similar structures.
13. Pallets of Lillestone at Grassy Mountain ready for shipment to Calgary.

Note the size of stone; pallets are one metre high and a little over one metre wide.

Note the colour, fairly regular shape, and the thickness of stone slabs. The stack of stone is 1.1 m high, the stone slabs are about 8 cm thick.
15. Outcrop of Greggstone at the south end of Pit No.H4-East, Gregg River Mine.

Note the dipslope configuration of this stone deposit. It has very good potential for a hillside quarry.
The top photograph shows bedding ranging from 3 cm to 11 cm. The bottom photograph shows strong separation along nearly vertical joints.
17.1 Rock needle (8x12 cm) of Greggstone; result of closely spaced parallel joints and bedding. This is a useful piece of stone.

17.2 Thin flagstone in the uppermost part of Greggstone outcrop. It develops at shallow depth as a result of frost action over long period of time.
18. Releasing a slab of Greggstone.

Note the even shape of the slab and lines of separation along bedding planes in the rock below the crow bar. The front vertical wall is where the rock separated along a joint plane.
19. Active waste dump at the Luscar Mine operated by Cardinal river Coal Ltd.

Possibly Torrens Member sandstone, a potentially useful but irregularly shaped rock similar to Lillestone from Grassy Mountain.
20.1 Weathered sandstone from waste rock dump at No.9 Mine, SRCL.
Note colour and shape. Obtaining a larger quantity of this stone would require careful picking of individual pieces from old dumps.

20.2 An older dump in No.9 Mine area, Smoky River Coal Ltd.
Mainly irregularly shaped rock with common flat side. Note various colours (light gray, ochre and some brown) and mix of solid and partly disintegrating rocks.
21.1 Outcrop of Torrens Sandstone in No.12 Mine West, Smoky River Coal Ltd. Note bedding plane separation and steepness of the rock.

21.2 Slabby stone from the upper part of above outcrop. Note the blue-gray colour of fresh stone.
22.1 Bench Sandstone in No.12 Mine West, Smoky River Coal Ltd.

Thin to medium bedded sandstone with minor carbonaceous shale and a coaly stringer. The interval is 1.1 m thick. Note better quality thick stone in the upper and thin stone in the bottom part of the unit.

22.2 Close-up of the bottom part of the above Bench Sandstone exposure.

The tape shows inches and 10 cm intervals. The middle layer shows a good quality “1.5 to 2 inch” flagstone. The layer above is inferior rock.
23.1 Pile of sandstone slabs from the upper part of Bench Sandstone; in Pit No.3, No.12 Mine West, Smoky River Coal Ltd.

23.2 Close-up of Bench Sandstone slabs. Smokystone mixed with inferior rock.

Note the thickness of the massive slabs; these must be moved away to gain better access to Smokystone in the pile.
24.1 Flaggy Smokystone. Note colour of the top, flat part of stone.

24.2 Yellow weathered joint sides of Smokystone.

Note the contrasting colour and shape of stone. The tape indicates 10 cm intervals. Pieces of the 2" stone are 7x10 cm to 30x50 cm.
25. Pallets of Smokystone at No. 12 Mine West, Smoky River Coal Ltd., ready for shipment to Edmonton.

Both pallets are 1.1 metre high. Note the average thickness of the thinner “2 inch” stone on the left pallet and of the thicker “4 inch” stone on the right pallet. The three colours (gray of broken stone, yellow of the weathered joints and white of fresh joints) are quite obvious.
27.1 Mortared Rundlestone facing on the entrance structure at Arbour Lake subdivision in NW Calgary.

27.2 Decorative structure clad with drypack Rundlestone.
28. Landscaping with large Rundlestone blocks
29. Drypack mini-wall built of Smokystone.

Note different colours of individual pieces with dominating medium gray and ripple marks on the large grayish-black stone. This is mainly the thin, “2” stone (ranging in thickness from 3 cm to 6 cm); and two pieces of thicker stone (8 cm thick).
APPENDIX 2.

BUILDING STONE DATA SHEETS
INDUSTRIAL MINERALS DATA SHEET

Commodity: STONE  
Date: 95/11/01  
By: Y. Horachek

**Lithology**

<table>
<thead>
<tr>
<th>SANDSTONE</th>
<th>Horizon/Member</th>
<th>Formation</th>
<th>Group</th>
<th>Stratigraphic Age</th>
<th>SAMPLE ID.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bench sandstone</td>
<td>Gates</td>
<td>Luscar</td>
<td>L. Cretaceous</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type of stone:** Rough building stone  
**Photos:** incl. in report Building Stone from Waste...

**Anticipated use:**  
Mainly in outdoor, possible rustic style interior applications.  
Stone wall facing and veneer.  
Drysone or mortared work.

**Trade name:** Smokystone

**Location name**

<table>
<thead>
<tr>
<th>No.12 Mine West</th>
<th>District</th>
<th>Alberta Land Survey Meridian (West of)</th>
<th>Township</th>
<th>Range</th>
<th>Sec.</th>
<th>Lsd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grande Cache</td>
<td>Smoky River</td>
<td>National Topographic Series</td>
<td>5989750</td>
<td>350550</td>
<td>83 L3</td>
<td>Copton Creek</td>
</tr>
</tbody>
</table>

**Land owner**  
Crown

**Mineral rights holder**  
Coal Ltd.

**Nature of the site:** Layers of sandstone on the footwall of mined out pit dipping at 40°.  
Loose slabs of sandstone that slid from the pit footwall.

**Access to the site:** Hwy 40 to SRCL, main mine road to No. 12 Mine area, road to Pit #3 in No.12 Mine West.

**PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Specific gravity</th>
<th>Water absorption [%], 1 hour:</th>
<th>2.69</th>
<th>Water absorption [%], 2 hours:</th>
<th>0.16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight [kg/m³]:</td>
<td>Compressive strength [MPa], dry:</td>
<td>2690</td>
<td>Compressive strength [MPa], wet:</td>
<td></td>
</tr>
<tr>
<td>Porosity [%]:</td>
<td>Comp. strength [MPa], after frost:</td>
<td></td>
<td>Transverse strength [MPa]:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shearing strength, [MPa]:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WEATHERING CHARACTERISTICS**

- Weight loss after 4 days soaking in 1% HCl [%]:
- Weight loss after 4 days soaking in 1% H₂SO₄ [%]:
- Weight loss, spalling, after heating to 800F [%]:
- Effects of 30 day repeated freeze and thaw:

**GEOLOGICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Structure</th>
<th>Strike</th>
<th>Dip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour, fresh: dark gray face, gray-black bedding</td>
<td>Thickness, overall [m]:</td>
<td>1</td>
<td>40-50°NE</td>
</tr>
<tr>
<td>Colour, weathered: reddish gray, gray-yellow joint sides</td>
<td>Benches, number of:</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Colour variation: range from medium to very dark gray</td>
<td>Bedding, thickness [m]:</td>
<td>0.05 - 0.3</td>
<td>306°</td>
</tr>
<tr>
<td>Texture: fine grained</td>
<td>Joints spacing, primary [m]:</td>
<td>not determined</td>
<td></td>
</tr>
<tr>
<td>Grain, general: fine grained</td>
<td>Joints spacing, secondary [m]:</td>
<td>not determined</td>
<td></td>
</tr>
<tr>
<td>Grain, size [mm]: quartz and chert</td>
<td>Separation (ease of):</td>
<td>easy</td>
<td></td>
</tr>
<tr>
<td>Composition: quartz and chert</td>
<td>Fracturing, general:</td>
<td>significant</td>
<td></td>
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<tr>
<td>Cement/Matrix: silica</td>
<td>Crossbedding, any?:</td>
<td>none, ripplemarks</td>
<td></td>
</tr>
<tr>
<td>Lamination: negligible</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SIZE**

<table>
<thead>
<tr>
<th>Flagstone</th>
<th>Blocky stone</th>
<th>Massive stone</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>[cm]</td>
<td>[cm]</td>
<td>[cm]</td>
<td></td>
</tr>
<tr>
<td>Typical thickness: 5 and 8</td>
<td>Typical size: 15</td>
<td>Rough block size:</td>
<td></td>
</tr>
<tr>
<td>Thin stone: 3 to 5</td>
<td>Small stone:</td>
<td>Finished block:</td>
<td></td>
</tr>
<tr>
<td>Thick stone: 8 to 12</td>
<td>Large stone:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WORKABILITY**

- Hardness: hard
- Dressing, generally: minor shape adjustments can be done, extensive dressing is difficult
- Chiseling factor: |

**REMARKS:**  
The stone comes in sizeable slabs which may or may not break into smaller pieces as they slide down the pitwall. Only about 25% of rock released from the pit footwall is good quality sandstone. Exploitation possible when reclamation is finished, later in 1996.
**INDUSTRIAL MINERALS DATA SHEET**

<table>
<thead>
<tr>
<th>Commodity:</th>
<th>STONE</th>
<th>Date:</th>
<th>95/11/01</th>
<th>By: Y. Horacek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithology</td>
<td>SANDSTONE</td>
<td>Horizon/Member</td>
<td>Formation Group</td>
<td>Stratigraphic Age</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Torrens Member</td>
<td>Gates</td>
<td>Luscar</td>
</tr>
<tr>
<td>Type of stone:</td>
<td>Rough building stone</td>
<td>Photos: incl. in report Building Stone from Waste...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticipated use:</td>
<td>Mainly in outdoor, possible rustic style interior applications. Outdoor stone construction. Stone wall facing. Retaining walls Drystone or mortared work.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade name:</td>
<td>Greggstone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location name</td>
<td>Gregg River Mine</td>
<td>District</td>
<td>Hinton</td>
<td>Alberta Land Survey Meridian (West of) 5 47 31 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Township</td>
<td>Range</td>
<td>Sec.</td>
</tr>
<tr>
<td>Land owner:</td>
<td>Crown</td>
<td>National Topographic Series Northing Easting Map 5882560 465950 83 F/3 Map name Cadomin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mineral rights holder:</td>
<td>Gregg River Coals Ltd.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of the site:</td>
<td>Mine road outcrop at the southeast end of Pit No.H4-East. The sandstone interval of interest is in a dip slope configuration with good potential for a hillside quarry.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to the site:</td>
<td>Highway #40 from Hinton to Gregg River Mine, mine road to Pit No. H4-East area.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PHYSICAL PROPERTIES**

| Specific gravity: | Water absorption [%], 1 hour: |
| Weight [kg/m³]: | Water absorption [%], 2 hours: |
| Porosity [%]: | Compressive strength [MPa], dry: |
|               | Compressive strength [MPa], wet: |
|               | Comp. strength [MPa], after frost: |
|               | Transverse strength [MPa]: |
|               | Shearing strength, [MPa]: |

**WEATHERING CHARACTERISTICS**

- Weight loss after 4 days soaking in 1% HCl [%]
- Weight loss after 4 days soaking in 1% H₂SO₄ [%]
- Weight loss, spalling, after heating to 800°F [%]
- Effects of 30 day repeated freeze and thaw:

**GEOLOGICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Structure Strike: 300°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour, fresh:</td>
<td>grey</td>
</tr>
<tr>
<td>Colour, weathered:</td>
<td>grayish-light brown, ochre brown</td>
</tr>
<tr>
<td>Colour variation:</td>
<td>grey to light brown</td>
</tr>
<tr>
<td>Texture:</td>
<td>medium to coarse grained</td>
</tr>
<tr>
<td>Grain, general:</td>
<td>chert and quartz</td>
</tr>
<tr>
<td>Grain, size [mm]:</td>
<td>silice, slightly calcareous</td>
</tr>
<tr>
<td>Composition:</td>
<td>negligible</td>
</tr>
<tr>
<td>Cement/Matrix:</td>
<td>Thickness, overall [m]: 8</td>
</tr>
<tr>
<td>Lamination:</td>
<td>Benches, number of: 6 to 8</td>
</tr>
<tr>
<td></td>
<td>Bedding, thickness [m]: 0.03 to 0.12</td>
</tr>
<tr>
<td></td>
<td>Joints spacing, primary [m]: 0.05 to 0.4</td>
</tr>
<tr>
<td></td>
<td>Joints spacing, secondary [m]: present, not meas'd</td>
</tr>
<tr>
<td></td>
<td>Separation (ease of): moderate</td>
</tr>
<tr>
<td></td>
<td>Fracturing, general: some</td>
</tr>
<tr>
<td></td>
<td>Crossbedding: some</td>
</tr>
</tbody>
</table>

**SIZE**

<table>
<thead>
<tr>
<th>Flagstone</th>
<th>Blocky stone</th>
<th>Massive stone [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical thickness:</td>
<td>Typical size: 15 to 20 thick Rough block size:</td>
<td></td>
</tr>
<tr>
<td>Thin stone:</td>
<td>Small stone: Finished block:</td>
<td></td>
</tr>
<tr>
<td>Thick stone:</td>
<td>Large stone:</td>
<td></td>
</tr>
</tbody>
</table>

**WORKABILITY**

- Hardness: hard
- Dressing, generally: Size adjustment of individual pieces is possible fairly easily. Extensive dressing is difficult.
- Chiseling factor: some

**REMARKS:**

Exploitation of this site will only be possible when mining in the area is finished.
INDUSTRIAL MINERALS DATA SHEET

Commodity: STONE  
Date: 95/11/01  
By: Y. Horachek

Lithology: SANDSTONE  
Horizon/Member: MOOSE MOUNTAIN  
Formation: MORRISSEY  
Group: KOOTENAY  
Stratigraphic Age: L. CRETAKEOUS

SAMPLE ID.

Type of stone: Rough building stone  
Photos should show stone colour (close up and distant), texture, outcrop character, finished or installed stone.

Anticipated use: Mainly in outdoor applications or in a rustic style interior. 
Retaining walls, curbs, thick stone facing, small structures; dry stone or mortared works.

Trade name: Limestone

Location name  
GRASSY MOUNTAIN  
District: CROWSNEST  
Alberta Land Survey: Meridian (West of) 5 
Township: 8  
Range: 3  
Sec.: 23  
Lsd: 8

Land owner: Home Oil  
National Topographic Series: Northing 5503660  
Easting: 685300  
Map: 82 G/9  
Map name: Blaimore

Nature of the site: Waste rock pile 60 m east of the most southern, abandoned open pit. 
Loose rock of variable size.

Access to the site: Gravel road from Blaimore golf course to Grassly Mountain.

PHYSICAL PROPERTIES

Specific gravity:  
Weight [kg/m³]:  
Porosity [%]:

Water absorption [%], 1 hour:
Water absorption [%], 2 hours:
Compressive strength [MPa], dry:
Compressive strength [MPa], wet:
Comp. strength [MPa], after frost:
Transverse strength [MPa]:
Shearing strength, [MPa]:

WEATHERING CHARACTERISTICS

Weight loss after 4 days soaking in 1% HCl [%]:
Weight loss after 4 days soaking in 1% H2SO4 [%]:
Weight loss, spalling, after heating to 800F [%]:
Effects of 30 day repeated freeze and thaw:

GEOLOGICAL PROPERTIES

Appearance  
Colour, fresh: gray  
 Colour, weathered: rusty brown, orange, gray-brown  
Colour variation: significant in the gray to brown range  
Texture  
Grain, general: medium to coarse  
Grain, size [mm]:  
Composition: quartz, chert  
Cement/Matrix: silica  
Lamination:

Structure  
Strike:  
Dip:

Thickness, overall [m]:  
Benches, number of:  
Bedding, thickness [m]:  
Joints spacing, primary [m]:  
Joints spacing, secondary [m]:  
Separation (ease of):  
Fracturing, general:  
Crossbedding, any?:

SIZE

Flagstone [cm]: not applicable  
Blocky stone [cm]: variable  
Massive stone [m]:

Typical thickness:  
Thin stone: Small stone: < 15 cm  
Thick stone: Large stone: > 30 cm

WORKABILITY

Hardness: hard  
Dressing, generally: minor shape adjustments can be done, extensive dressing is difficult  
Chiseling factor:

REMARKS: