RSH - Any ideas on what to do with this one?

DKB[illegible]

Memorandum for Record

December 1, 1965

To: H.D. Thomas, State Geologist

From: M.L. Millgate

Subject: Sampling of limestone and gypsum in the Newcastle area, Wyoming, July, 1965

INTRODUCTION

start report here!

## INTRODUCTION

The Chamber of Commerce of Newcastle, Wyoming has undertaken a sampling program to determine the quality of mineral commodities, exclusive of petroleum and natural gas, which occur in the Newcastle area. During the week of July 11-17, 1965, the writer familiarized Chamber of Commerce representatives with sampling techniques and with known outcrop areas of selected mineral commodities. The writer appreciates the cooperation and courtesy extended by the Newcastle Chamber of Commerce and by Mr. J. S. Van Lieu, U. S. Geological Survey, currently conducting mapping in the Newcastle vicinity.

Uranium, bentonite and other clays, coal, limestone, gypsum, aggregate, and stone suitable for aggregate occur in the Newcastle area (Osterwald and others, 1959; Mapel and Pillmore, 1963). Limestone and gypsum were chosen for initial sampling because of their extensive occurrence, ease of access, and the fact that these commodities can be easily recognized at the land surface.

Initial work included sampling of the Pahasapa limestone, Minnekahta limestone, Gypsum Spring formation, and a thick gypsum bed in the Spearfish formation.

With one exception (sample listed as "grab"), all samples are chip samples taken with effort by estimate to secure equal volumes of rock from equally spaced points (1-2 feet) over the sample interval. Thus, assay results are fairly reliable.

These samples were assayed by the Natural Resources Research Institute, Laramie, Wyoming. The results of assay and comments of the N. R. R. I. concerning these results are appended.

## DESCRIPTION AND SAMPLING

### Pahasapa limestone

The Pahasapa limestone of Mississippian age consists of about 450-600 feet of mostly light-grey limestone and dolomite. (Mapel and Pillmore, 1963b, p. N 7; Mapel and Pillmore, 1963a, p. M 7; Robinson and others, 1964, p. 7). The formation is predominantly fine to very-fine grained, hard, massive, and commonly contains thin layers and nodules of white, grey, and buff chert in the upper part.

This limestone unit crops out in sections 16, 21, and 28, T. 45 N., R. 60 W., near Newcastle (Epstein, 1958). The most extensive exposure occurs along the upper reaches of Scott Canyon, an intermittent tributary to Stockade Beaver Creek. Other outcrops to the north of Scott Canyon are of more limited areal extent.

A previous analysis of this unit showed significant magnesia (MgO) content (Osterwald and others, 1959, p. 166), but no sample thickness was recorded. The top 176 feet of the Pahasapa limestone is well exposed and in sec. 28 is ammenable to open-pit mining methods. Samples were cut over the exposed formation thickness. A few chert layers are not included in the samples, but are included in the sample log. For purposes of evaluation, these chert layers can be assumed to 100% silica ($SiO_2$).

### Sample Log

Location: Grab - About 1720 ft. N. of S. line and 180 ft. E. of W. line, sec. 28, T. 45 N., R. 60 W., Weston Co., Wyoming. Ref. U.S.G.S. Fanny Peak ($7\frac{1}{2}'$) Quad.

L-1 through L-9 - Beginning with L-1 about 1660 ft. N. of S. line and 580 ft. E. of W. line and ending with L-9 about 1360 ft. N. of S. line 620 ft. E. of W. line, sec. 28, T. 45 N., R. 60 W., Weston Co., Wyoming. Ref. U.S.G.S. Fanny Peak ($7\frac{1}{2}'$) Quad.

| Sample No. | Interval (ft.) | Field Description | Thickness (ft.) |
|---|---|---|---|
| Grab | 0-≈30 | Taken from near the top of the Pahasapa limestone. Interval mostly covered. Light grey, very-finely grained limestone. | ≈ 30 |
| L-1 | ≈ 30-53 | Light grey to white, very fine grained, massive limestone | 23 |
| L-2 | 53-54 | Grey, massive limestone | 1 |
| | 54-56 | Chert, not sampled. | 2 |
| | 56-61½ | Grey, massive limestone | 5½ |
| | 61½-69½ | Covered | 8 |
| | 69½-70 | Chert | ½ |
| L-3 | 70-87 | Grey, very-fine grained massive limestone. 0.3-0.5 feet chert 3 feet above base of sample interval | 17 |
| | 87-87½ | Chert | ½ |
| L-4 | 87½-100½ | Grey, thin-bedded limestone | 13 |
| | 100½-101 | White chert | ½ |
| L-5 | 101-113 | Multicolored, fractured, thin-bedded, cherty dolomite* | 12 |
| L-6 | 113-130 | Grey, massive limestone becoming pink in the bottom 2 feet; intensely fractured at the top | 17 |
| L-7 | 130-137½ | Light pink to buff, becoming buff at the bottom, thin bedded, platy dolomite | 7½ |
| L-8 | 137½-168½ | Mostly grey with some pink, massive limestone. 0.2-0.3 ft. chert at the top | 31 |
| | 168½-169 | 0.3 feet chert. Not sampled | ½ |
| | 169-170½ | Grey limestone | 1½ |

* Dolomite as shown by chemical analysis.

| Sample No. | Interval (ft.) | Field Description | Thickness (ft.) |
| --- | --- | --- | --- |
| L-9 | $170\frac{1}{2}$-176 | Light pink to buff, very-fine grained, thin bedded, cherty dolomite. 4 chert layers 0.1-0.2 feet thick and some chert nodules in the interval | $5\frac{1}{2}$ |

~~* Dolomite as shown by chemical analysis.~~

Minnekahta Limestone

The Minnekahta limestone of Permian age is composed of laminated light grey and lavender limestone (Mapel and Pillmore, 1963b, p. N 7; Mapel and Pillmore, 1963a, p. M 6; Robinson and others, 1964, p. 7). This unit is 25 to 40 feet thick (Epstein, 1958, p. 11). In localities where sampled during the present investigation the thickness of the formation is more nearly 20 feet than 40 feet. Epstein (1948, p. 38) reports silty beds in the bottom 2 to 3 feet of the formation. These beds are not represented in the samples, nor were they identified in the field. Similar silty beds 2 to 3 feet thick occur in the middle of the unit and may be represented in sample L-12.

This limestone crops out extensively along the east side of Stockade Beaver Creek (Epstein, 1958) and in the southern part of Canyon Springs Prairie along U.S. Highway 85 in the vicinity of Four Corners, about 19 miles northeast of Newcastle. Thus, the Minnekahta limestone occurs at land surface over large areas and is ammendable to open-pit mining methods in these areas.

Several previous assays of this limestone showed high lime (CaO) content. These assays and the publications where they may be found as listed below.

From Osterwald ~~et al.~~ and others, 1959, p. 166

| | (A) | (B) |
|---|---|---|
| $SiO_2$ | 1.08% | 1.42% |
| $Al_2O_3$ | .33 | .68 |
| $Fe_2O_3$ | .77 | .40 |
| MnO | .46 | .11 |
| CaO | 53.40 | 52.85 |
| MgO | .57 | .72 |
| $SO_3$ | .12 | .12 |
| $Na_2O$ | .36 | .76 |
| $K_2O$ | .16 | .30 |
| $H_2O$ | .20 | .10 |
| Loss | 42.92 | 42.98 |

(A) Minnekahta limestone $1\frac{1}{2}$ mi. north and a little east of the LAK ranch on the east side of Stockade Beaver Creek.

(B) Minnekahta limestone 2 3/4 mi. north and a little east of the LAK ranch on the east side of Stockade Beaver Creek.

From Robinson ~~et al.~~ and others, 1964, p. 8

| | (C) | (D) | (E) |
|---|---|---|---|
| Insoluble in HCl | | 1.37% | 2.5% |
| MgO | 0.36% | 20.46 | Trace |
| CaO | 54.54 | 31.28 | 54.6 |
| $CO_2$ | | 45.68 | |
| $SO_3$ | Negligible | .71 | |
| $H_2O^+$ | | .64 | |
| $H_2O^-$ | | .22 | |
| | | 100.36 | |

(C) SE$\frac{1}{4}$ sec. 4, T. 52 N., R. 61 W

(D) Center S$\frac{1}{2}$ sec. 18, T. 52 N., R. 61 W.

(E) SW$\frac{1}{4}$ sec. 9, T. 49 N., R. 62 W.

Analyses from elsewhere in the Black Hills (Darton and Paige, 1925, p. 9) show magnesia contents ranging from 0.41 to 19.85 percent (Mapel and Pillmore, 1963d, p. M 10)

For these assays no sample intervals are available. During the present sampling three samples were taken from the Minnekahta limestone. The sample log is given below:

Sample No.: L-10

Location: In quarry face in SE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 8, T. 44 N., R. 60 W., Weston Co., Wyoming. Ref. U.S.G.S. Newcastle (15') Quad.

Interval: 21 ft.

Field description: Lavender, thick-bedded limestone. Most of the thickness of the Minnekahta limestone is represented in the sample. Limestone from this quarry was used as road metal.

Sample No.: L-11

Location: In quarry face in NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 5, T. 44 N., R. 60 W., Weston Co., Wyoming. Ref. U.S.G.S. Fanny Peak (7$\frac{1}{2}$') Quad.

Interval: 19.1 ft.

Field description: Lavender and grey, laminated (0.1-5.0 mm), thin bedded, very-fine to fine grained, homogeneous limestone. Most of the thickness of the Minnekahta is represented. Limestone from this quarry was used as road metal. Sample point is about 740 ft. S. of N. line and 440 ft. W. of E. line, sec. 5.

Sample No. L-12

Location: In road cut, NW$\frac{1}{4}$ NW$\frac{1}{4}$ sec. 11, T. 47 N., R. 61 W., Weston Co. Wyoming. Ref. U.S.G.S. Four Corners (15') Quad.

Interval: 21.5 feet

Field Description: Lavender, laminated, very-fine to fine grained limestone. Neither top nor bottom of Minnekahta limestone was seen at this point. Sample point is about 550 ft. S. of N. line and 220 ft. W. of E. line, sec. 11.

## Spearfish formation

The Spearfish formation of Permian and Triassic age is 450 to 650 feet thick and is composed mostly of red claystones, siltstones, and sandstones; interlayered with massive gypsum beds in the lower part (Mapel and Pillmore 1963a, p. M 7; 1963b, p. N 6). The Spearfish formation crops out in much of the valley of Stockade Beaver Creek and is continuous northward into the eastern part of the Canyon Springs Prairie.

Over much of the outcrop area the gypsum layers do not exceed about 12 feet in thickness and are commonly about 2 to 5 feet thick. Much of the gypsum exposed at the surface is greatly stained and adulterated with red siltstone derived mostly from overlying beds during weathering processes. Further, the western and southwestern dips are sufficiently steep in many places to make open-pit mining methods unfeasible.

Mapel and Pillmore (1963b, p. N 10) measured 27 feet of gypsum in the lower part of the Spearfish formation in NW$\frac{1}{4}$ SW$\frac{1}{4}$ and NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 8, T.48 N., R.60 W. This bed makes up much of a large hill situated in secs. 5, 6, 7, and 8. Gypsum crops out on the north, east, and south sides of the hill. The western side of the hill was not examined. Assuming no change in thickness of the gypsum layer, several tens of millions of tons of gypsum occur near land surface. Beds overlying the gypsum consist mostly of siltstone which could probably be ripped without ~~recourse to~~ blasting. Of the areas visited during this brief investigation, this locality is the most favorable for mining.

The gypsum layer occurring in section 8 was sampled as follows:

Sample No.: G-3

Location: NW$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 8, T. 46 N., R. 60 W., Weston Co., Wyoming.
Ref. Newcastle (15') Quad.

Interval: 21 feet

Field Description: Light pink, hard, massive gypsum. 4 feet of overlying interbedded siltstone and gypsum not sampled. The lower part of the gypsum bed was not sampled because of cover.

## Gypsum Spring formation

The Gypsum Spring formation of Jurassic age consists of 0-20 feet of massive gypsum in the Newcastle area (Mapel and Pillmore, 1963b). This gypsum layer occurs as narrow exposures in the bluffs forming the western side of the valley of Stockade Beaver Creek and similarly along the LAK Draw to the south. This outcrop is fairly continuous to the northeast into the Inyan Kara Mountain area (Mapel and Pillmore, 1963d)

In most places the Gypsum Spring formation is overlain by a thick sequence of younger rocks, making unfeasible all but underground mining methods. It is possible that a detailed examination of the outcrop may reveal some areas of little or no overburden where gypsum may be mined at the surface or with minor stripping of overlying rocks. Because the formation is thin, several such areas might be necessary to provide the large tonnages of gypsum necessary to a modern gypsum mining operation.

Previous assays of samples from the Gypsum Spring formation are listed below:

From Mapel and Pillmore, 1963d, p. M 51

| | (A) | (B) |
|---|---|---|
| CaO | 33.9% | 33.2% |
| MgO | 0.93 | $<$ 0.5 |
| $SO_3$ | 42.2 | 45.8 |
| $CO_2$ | 3.54 | 1.09 |
| $H_2O$ @ 105° C | 18.38 | 19.57 |
| Ignition Loss @ 1000° C | 4.96 | 2.06 |
| Insoluble in 1:1 HCl | 0.34 | .25 |
| | | |
| Gypsum | 91% | 98% |
| Calcite | 7 | 2 |
| Magnesite [1] | 1 | - |
| Insoluble | $<\frac{1}{2}$ | $<\frac{1}{2}$ |

(A) Gypsum Spring formation, bottom part of 10-ft. bed, SW$\frac{1}{4}$ sec. 12, T.47 N., R.62 W.

(B) Gypsum Spring formation, top part of 10-ft. bed, SW$\frac{1}{4}$ sec. 12, T. 47 N., R. 62 W.

[1] Magnesium in the samples probably in the form of dolomite, but is reported as magnesite for ease in computation.

A sample of the Gypsum Spring formation was taken at Salt Springs on Salt Creek. Along the upper reaches of Salt Creek the beds overlying the Gypsum Spring formation have been partially removed by erosion, thus enhancing the possibility that areas of gypsum beneath relatively thin overburden be found. The sample was logged as follows:

Sample No.: G-2

Location: On the south side of Salt Creek by Salt Springs in NE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 9, T. 46 N., R. 61 W., Weston Co., Wyoming. Ref. U.S.G.S. Newcastle (15') Quad.

Interval: 9.2 feet

Field Description: White, hard, massive gypsum with abundant red laminae. The entire thickness of the Gypsum Springs formation is represented in the sample.

## CONCLUSIONS

With the exception of about the top 30 feet of the Pahasapa limestone, which is poorly sampled, this unit contains too much magnesia and silica for most chemical and industrial purposes. Because the bulk of the exposed rock is unsuitable, the large outcrop area of Pahasapa limestone is no longer attractive. Tough, overlying rocks must be stripped or underground mining methods employed to utilize the top layers of limestone; thus greatly increasing mining costs. Because of poor location of the outcrop area with respect to available transportation and markets this unit is an unlikely source of low-cost, bulk products such as crushed stone for use as road metal or agricultural purposes. At the present time, the Pahasapa limestone in the Newcastle area is unworthy of further consideration as a source of limestone.

The available sample assays of Minnekahta limestone indicate this unit is probably suitable as a limestone source for most chemical and industrial purposes. The limestone is probably of good quality in most places, but locally has high magnesia content (Darton and Paige, 1925, p. 9; Robinson and others, 1964, p. 8). Large tonnages of limestone can be recovered from this unit with minor stripping of overburden because the unit characterictically forms the land surface over large areas. If further sampling is carried out, it should be done in areas most favorable for mining and best situated with respect to existing transport, water supply, and fuel supply.

Gypsum in the Gypsum Spring and Spearfish formations is suitable for many industrial purposes, but suffers some disadvantages. The occurrence of gypsum in thin beds in conjunction with relatively high dips greatly limits the areas in which open-pit mining methods could be best utilized. The most favorable mining site found during this examination was in sec. 8, T. 48 N., R. 60 W.

Much of the gypsum contains abundant red laminae. These laminae do not appreciably effect the chemical quality of the gypsum, but do impart a pale color which may be undesirable. The degree to which this color might persist during a manufacturing process is not known, but could be determined by physical testing. If the gypsum is used in small amounts as a set-control additive in cement manufacture, the color would probably be of no consequence.

The N.R.R.I. points out that "cement rock" will be needed in the process of cement manufacture (see appended letter). Such raw material can probably be located in the Morrison formation or Belle Fourche shale near Newcastle (Osterwald and others, 1959, p. 168-169).

The results of this brief investigation indicate that there are considerable reserves of limestone and gypsum in the Newcastle area. Information presently available indicates that these reserves are probably suitable for industrial use. More information is needed before specific evaluations and site locations can be made. Ultimately these decisions must be made by the investor organization intending to exploit the area.

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NATURAL RESOURCES RESEARCH INSTITUTE
COLLEGE OF ENGINEERING
UNIVERSITY OF WYOMING
LARAMIE, WYOMING

November 17, 1965

Mr. B. T. Sheldon
Field Director of Industrial Development
Wyoming Natural Resource Board
Supreme Court Building
Cheyenne, Wyoming

Re: Samples from Newcastle Area

Dear Mr. Sheldon:

I am taking this means of reporting the analyses and computations done on this suite of samples because at this stage it does not appear to warrant a more formal report.

It was assumed when we discussed this at first that the samples would be largely high-calcium limestones and not the dolomitic variety which largely proved to be the case. Limestone for cement production must be low in magnesium because the specifications for cement will restrict the MgO contents to less than 5.0 percent. Thus, because of the shrinkage, the raw material should carry less than 3.0 percent and preferably less than 2.0 percent. Only four of the thirteen samples would be regarded as suitable stone: Grab, L-10, L-11 and L-12.

Either gypsum would probably serve as the set-control addition which is added during the final grinding of the cement. Obviously the more nearly pure one would be preferred.

In addition to limestone, some "cement rock" consisting of shale or clay (again low in magnesium and possibly high in linestone) will be required to furnish silica, alumina and possibly iron to complete the raw material requirements. Iron is frequently added as iron ore. Eventually attention should be paid to the alkali content of any raw materials but this is further down the road.

We will be glad to go further into this matter if the occasion demands; even as far as blending, firing, grinding and testing of the finished cement as I assured you.

Sincerely,
NATURAL RESOURCES RESEARCH INSTITUTE

Walter E. Duncan

Walter E. Duncan, Associate Director

WED:th

## Sample No. 3837

### Analysis of Gypsum and Limestone

#### Analysis, Percent

| Sample No. | CaO | MgO | Ignition Loss | $SO_3$ | Water, Comb'd. | Water, Free | $Fe_2O_3$ | $Al_2O_3$ | $SiO_2$ |
|---|---|---|---|---|---|---|---|---|---|
| G-2 | 33.9 | - | 2.3 | 44.3 | 14.9 | 0.5 | 0.1 | 0.2 | 0.5 |
| G-3 | 32.4 | 1.6 | 4.3 | 42.1 | 15.5 | 0.3 | 0.2 | 0.3 | 1.8 |
| Grab | 56.6 | 0.5 | 41.5 | 0.5 | 0.3 | 0.1 | 0.3 | 0.2 | 0.3 |
| L-1 | 52.2 | 2.6 | 40.8 | 0.3 | 0.3 | 0.1 | 0.3 | 0.4 | 3.1 |
| L-2 | 46.0 | 5.5 | 39.5 | 0.2 | 0.3 | 0.1 | 0.7 | 0.6 | 6.8 |
| L-3 | 49.2 | 5.0 | 40.2 | 0.1 | 0.3 | 0.1 | 0.3 | 0.2 | 3.5 |
| L-4 | 44.0 | 9.0 | 44.3 | 0.2 | 0.4 | 0.1 | 0.3 | 0.3 | 1.0 |
| L-5 | 26.5 | 12.2 | 31.7 | 0.3 | 0.4 | <0.1 | 3.3 | <0.1 | 25.6 |
| L-6 | 49.6 | 4.6 | 43.7 | 0.2 | 0.4 | 0.1 | 0.3 | 0.1 | 1.0 |
| L-7 | 34.2 | 11.8 | 46.0 | 0.4 | 0.3 | <0.1 | 0.3 | 0.3 | 0.5 |
| L-8 | 49.5 | 5.4 | 41.7 | 0.3 | 0.3 | 0.1 | 0.3 | 0.3 | 2.3 |
| L-9 | 30.0 | 16.8 | 39.7 | 0.5 | 0.5 | 0.2 | 1.6 | 0.1 | 9.9 |
| L-10 | 53.7 | 0.4 | 41.1 | 0.5 | 0.4 | 0.2 | 0.3 | 0.1 | 3.3 |
| L-11 | 54.1 | 0.3 | 42.4 | 0.1 | 0.2 | <0.1 | 0.2 | 0.4 | 2.3 |
| L-12 | 55.0 | 0.6 | 41.7 | 0.5 | 0.2 | 0.2 | 0.1 | 0.5 | 1.5 |

### Recalculation of Analysis, Percent

| | Gypsum $CaSO_4 \cdot 2H_2O$ | Magnesite $MgCO_3$ | Calcite $CaCO_3$ | Other | Total |
|---|---|---|---|---|---|
| G-2 | 95.3 | - | 5.2 | 1.3 | 101.8 |
| G-3 | 90.6 | 3.3 | 5.2 | 2.3 | 101.4 |
| Grab | 1.1 | 1.1 | 94.1 | 4.8 | 101.1 |
| L-1 | 0.6 | 5.4 | 86.4 | 5.8 | 98.2 |
| L-2 | 0.4 | 11.5 | 76.2 | 11.6 | 99.7 |
| L-3 | 0.2 | 10.5 | 79.0 | 9.2 | 98.9 |
| L-4 | 0.4 | 18.8 | 81.9 | 1.9 | 103.0 |
| L-5 | 0.6 | 25.5 | 41.8 | 31.8 | 99.7 |
| L-6 | 0.4 | 9.6 | 88.0 | 2.0 | 100.0 |
| L-7 | 0.9 | 24.7 | 75.5 | 1.2 | 102.3 |
| L-8 | 0.7 | 11.3 | 81.5 | 3.2 | 96.7 |
| L-9 | 1.1 | 35.1 | 48.6 | 13.5 | 98.3 |
| L-10 | 1.1 | 0.8 | 92.4 | 5.7 | 100.0 |
| L-11 | 0.2 | 0.6 | 95.7 | 3.5 | 100.0 |
| L-12 | 1.1 | 1.3 | 93.4 | 4.6 | 100.4 |