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BENCH TESTING OF SILICA SAND FROM DEPOSITS IN CLATSOP AND MORROW COUNTIES, OREGON

by

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This work was funded in part by the Port of Morrow

N O T I C E

The Oregon Department of Geology and Mineral Industries is publishing this paper because the subject matter is consistent with the mission of the Department. To facilitate timely distribution of information, this paper has not been edited to our usual standards.

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INTRODUCTION

Summary

Silica sand samples were collected from six deposits in Clatsop and Morrow Counties. Figure 1 shows the location of the two sample-location maps. Each sample was assayed, sized, magnetic and gravity separated, and re-assayed. The main conclusion of this study is that a silica sand product can be produced from the three deposits in Clatsop County. The silica fractions of the samples (31 to 40 percent of the total sample) from these three deposits range from 94.0 to 96.7 percent SiO_2 and from 0.44 to 0.45 percent Fe_2O_3.

Study Limitations

For this reconnaissance study, only one sample for assaying and testing was collected from each of six deposits. To make definitive statements about any mineral deposit, at least three samples must be taken from each deposit. From these one could obtain the mean and variance. Without these two statistics, there is no statistical way to tell how representative the sampling had been.

The sample analysis was by X-ray fluorescence, a technique that is suitable for reconnaissance-level study. Higher-level study would require analysis by other means. The samples were not tested to see if a silica product could be obtained using flotation as the method of beneficiation. The samples were

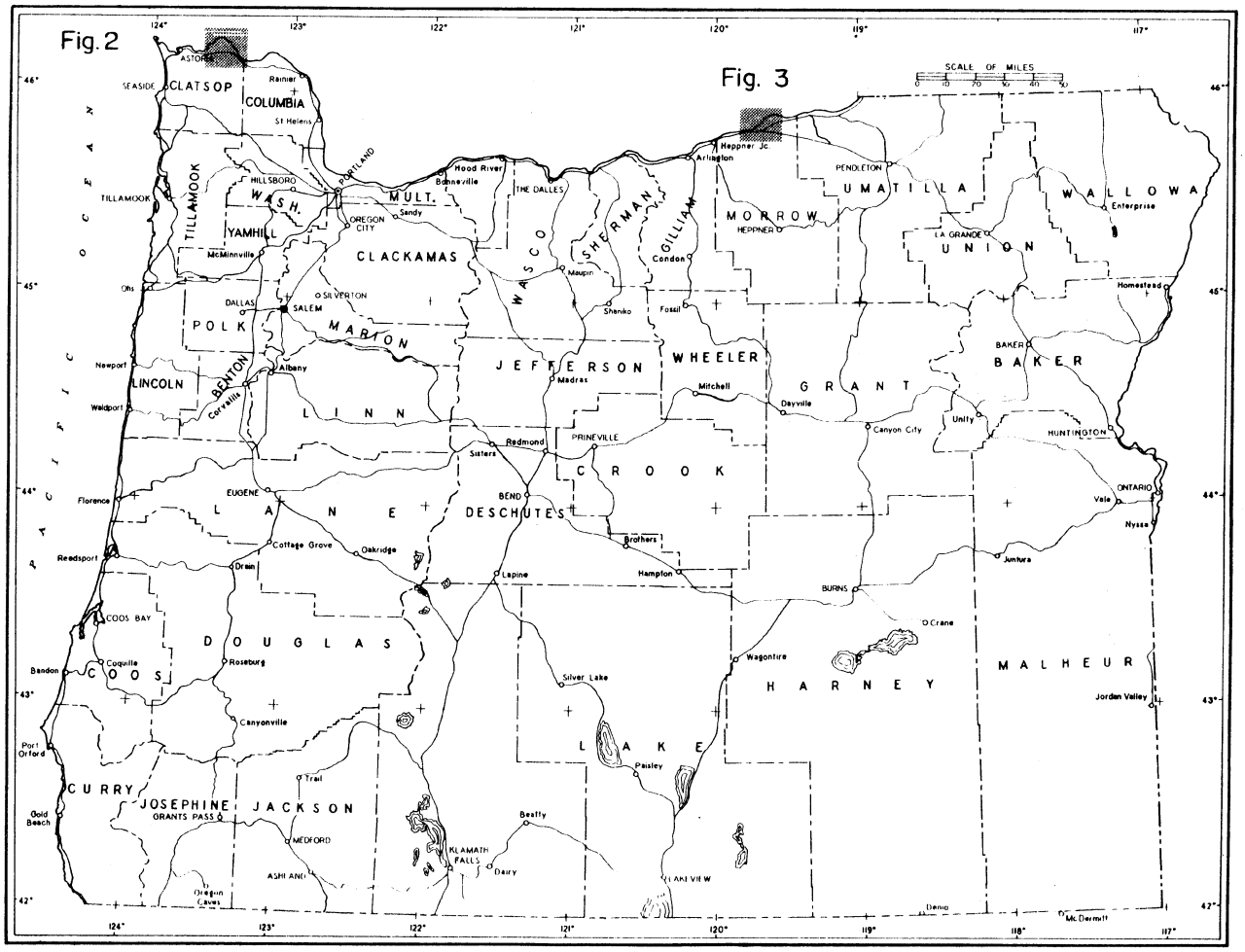

Figure 1. Index map showing location of Clatsop County sample-location map (Figure 2) and Morrow County sample-location map (Figure 3).

not studied petrographically, although it is recognized that for some uses of silica sand a few grains of refractory minerals such as corundum, kyanite, or zircon would be detrimental for a final product. The samples were simple grab samples. There were no detailed geological studies of the deposits available to guide sampling. No attempt was made to examine the economics and/or markets for the sample sites.

Cooperator/Funding

This study was a cooperative effort by the Department, the Port of Morrow, the Mineral Resource Institute of the University of Alabama, and a private industrial firm. The Department collected the samples, the Mineral Resource Institute performed the bench testing, the Port of Morrow provided the funding ($2,500) for the bench testing, and the industrial firm used X-ray fluorescence to assay the raw sand samples and the silica fraction of these samples.

Acknowledgments

The people directly involved with this study were Wayne L. Schwandt, Manager, Port of Morrow, and Dr. R. Bruce Tippin, Director, and Dr. W.E. Lamont, Research associate, Mineral Resource Institute. Richard Schulberg of the Oregon Economic Development Department was instrumental in arranging the funding from the Port of Morrow for the bench testing.

DEPOSITS DESCRIPTION

The locations of the first three sample sites are in Clatsop County and are shown on Figure 2. The sample sites are all in an upper Miocene sandstone shown by the shading on Figure 2. The total unit is from 500 to 1,000 ft thick. The lower parts of the unit consist of friable, coarse- to medium-grained, massive arkosic sandstone. Sample sites 1 and 2 are in quarries, and site 3

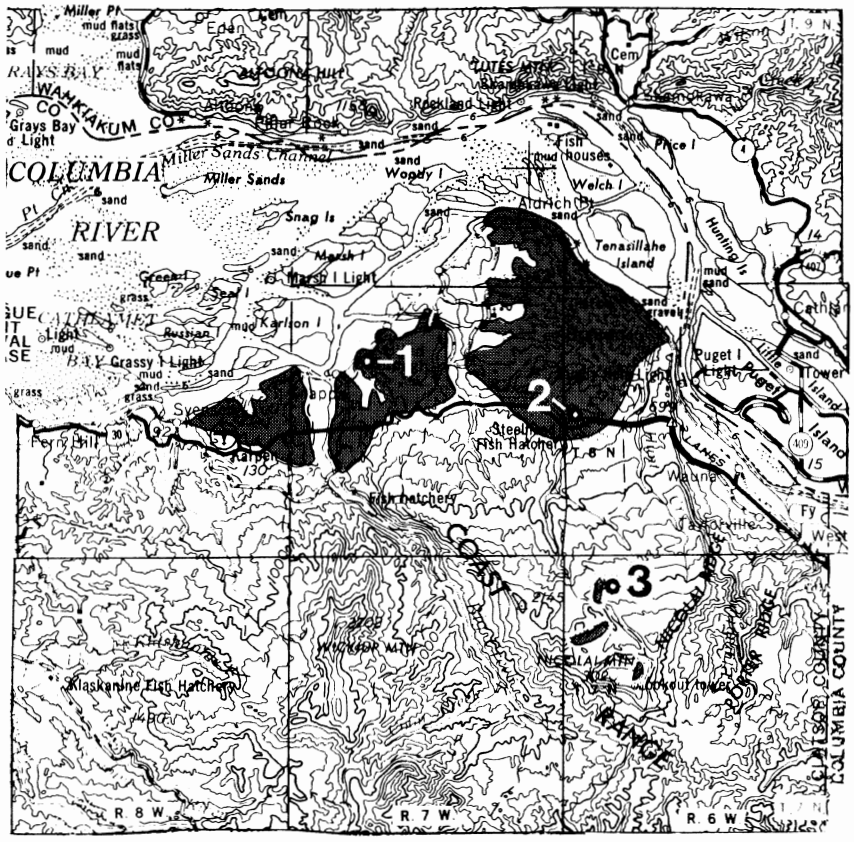

Figure 2. Clatsop County sample-site locations and upper Miocene sandstone outcrop map.*

Scale 1:250,000

Sample site ●1

Upper Miocene sandstone

*Geology taken from Beaulieu, J.D., 1973, Environmental geology of inland Tillamook and Clatsop Counties, Oregon: Oregon Department of Geology and Mineral Industries Bulletin 79, 65 p.

is a roadside outcrop. Material from site 1 is being used for construction fill. The quarry at site 2 had been used as a source of silica for cement manufacture.

The three deposits sampled in Morrow County (Figure 3) are from three different geologic units. Site 4 is in washed sand from an unconsolidated fluvioglacial sand and gravel deposit which is presently being mined for aggregate. Site 5 is in one of several active dunes in the area. Site 6 is in glacial-lake silt and sand.

All six samples taken represent large-tonnage resources. The legal descriptions of the sample sites are given in the following table:

Table 1. Sample Site Legal Description

Figure 1 or 2 Site Number	County	Sample Type	Township	Range	Section	¼ Section
1	Clatsop	Sandstone	8N	7W	8	NE
2	Clatsop	Sandstone	8N	6W	19	NW
3	Clatsop	Sandstone	7N	6W	6	SE
4	Morrow	Washed sand	4N	25E	10	NE
5	Morrow	Dune sand	4N	25E	20	SW
6	Morrow	Glacial-lake sediments	3N	26E	29	NW

SAMPLE QUALITY

Markets for silica sand have varying sets of standards including the allowable ranges for grain size and chemical content. For comparisons in this study, the Department assumed a set of standards that should meet the

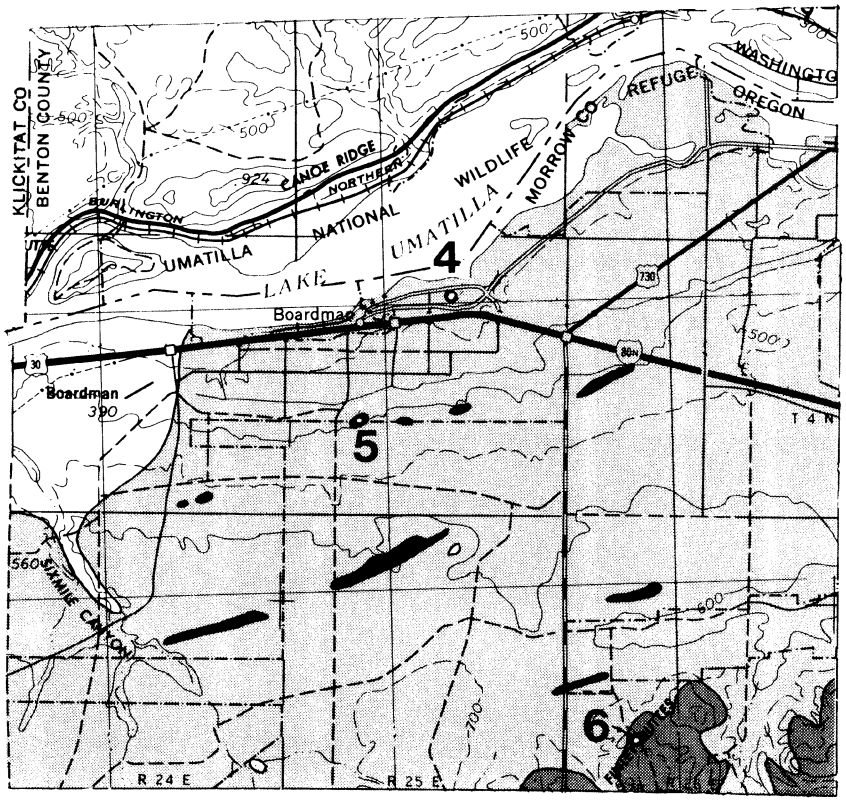

Figure 3. Morrow County sample-site locations and fluvioglacial, sand dune, and glacial-lake sediment deposits map.*

Scale 1:250,000

Sample site ∘6

Fluvioglacial deposit

Sand dune

Glacial-lake deposit

* Geology taken from Walker, G.W., 1973, Reconnaissance geologic map of the Pendleton quadrangle, Oregon and Washington: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-727.

most stringent silica sand markets. The Department assumed that all the sand grains must be smaller than 20 mesh, only one percent can be larger than 30 mesh, and only five percent can be smaller than 140 mesh. The Department also assumed that the silica content of the sand should be at least 98 percent and the iron content should be less than 0.04 percent.

The samples were dried, assayed, and screened. The assaying was done in the laboratory of an industrial firm that uses X-ray fluorescence for assaying samples taken for process and quality control of the firm's raw materials and output. Table 2 contains the assay data for each sample and the assumed specifications for comparison. The raw sand samples did not meet the assumed silica specifications and were well over the assumed iron specifications. Table 3 shows that the weight percent of sand grains that were assumed to be too coarse or too fine ranged from 10.2 percent for the dune deposit to 60.1 percent for the glacial-lake sediment.

Table 2. Raw sample assay data compared to assumed specifications

Major oxides	Assumed specifications	Raw sample chemistry (weight percent)					
		Figure 2 sample sites			Figure 3 sample sites		
		1	2	3	4	5	6
SiO_2	>98.0	80.12	80.63	78.46	70.06	70.15	67.07
Al_2O_3	---	10.67	13.38	14.82	12.76	12.97	13.89
TiO_2	---	---	---	---	0.13	0.14	0.22
Fe_2O_3	< 0.04	3.14	2.28	3.32	5.85	5.58	6.65
CaO	---	1.57	1.27	1.20	3.39	3.07	3.53
MgO	---	0.67	0.60	0.60	1.36	1.16	1.74
Na_2O	---	1.12	1.10	0.43	1.90	1.50	1.67
K_2O	---	2.11	2.31	2.34	1.97	1.98	1.86
SO_3	---	0.19	0.20	0.24	0.0	0.9	0.02
TOTAL	98.04	99.59	101.77	101.41	97.42	97.45	96.65

Table 3. Dry size analyses of raw sand samples

Size, Mesh*	Raw sample size fractions (weight percent)					
	Figure 2 sample sites			Figure 3 sample sites		
	1	2	3	1	2	3
Plus 20	10.9	1.0	2.8	32.3	0.2	0.3
20/28	15.6	11.7	9.8	11.6	2.4	0.1
Too coarse	26.5	12.7	12.6	43.9	2.6	0.4
28/35	13.8	21.0	11.8	12.6	9.0	0.3
35/48	24.2	38.3	29.4	20.2	18.7	1.0
48/65	14.5	14.5	20.8	12.5	24.4	3.5
65/100	9.7	4.6	9.6	6.7	26.7	13.2
100/150	4.2	1.9	3.7	2.3	11.0	21.9
Correct size	66.4	80.3	75.3	54.3	89.8	39.9
150/200	3.0	1.9	3.3	1.1	6.0	34.5
Minus 200	4.1	5.1	8.8	0.7	1.6	25.2
Too fine	7.1	7.0	12.1	1.8	7.6	59.7
TOTAL REJECT	33.6	19.7	24.7	45.7	10.2	60.1
Composite	100.0	100.0	100.0	100.0	100.0	100.0

*Tyler series, 15 minutes on RoTap.

BENEFICIATION TESTING AND RESULTS

Very few silica sand deposits can directly produce material that can be used in industry. Whether or not a deposit could be a commercial supplier of silica sand may depend less on the raw sand assays than on ease of beneficiation and available markets for the reject material. The Mineral Resource Institute subjected the -28/+150 mesh fraction (Table 3) of the six samples to wet scrubbing that removed the clays, three stages of high-intensity magnetic separation, and three stages of heavy liquid separation. Other beneficiation techniques such as flotation were not tried. Flotation would be the beneficiation technique used in a commercial size plant.

The nonmagnetic portion of each sample was split into three fractions: (1) that which sank in 2.7-specific gravity (sp.gr.) liquid, (2) that which floated in 2.7- but sank in 2.6-sp.gr. liquid (silica fraction), and (3) that which floated on 2.6-sp.gr. liquid. Table 4 indicates the fraction of sand, by weight percent, that was nonmagnetic and had a specific gravity of quartz (silica) of both the total sample and the -28/+150 mesh portion of the total sample. Table 4 indicates that from 93.8 to 61.1 percent of the mine-run sand would have to be rejected to produce a silica fraction. The rejected material was mostly clay and feldspar.

The silica fraction of each sample was assayed by X-ray fluorescence. As Table 5 shows, the three samples from Clatsop County were close to the assumed silica sand specifications. The silica percentage was 4 percent low, and the iron content was too high by a factor of 10.

CONCLUSIONS AND RECOMMENDATIONS

Although the sandstones can be considered a potential silica sand source, a much more in-depth study must be made before any decision can be made on the

Table 4. Silica fraction percent of the total sample and of the -28/+150 mesh portion of the total sample

Sample type	Silica fraction (weight percent)					
	Figure 2 sample sites			Figure 3 sample sites		
	1	2	3	4	5	6
-28/+150 mesh portion of raw sample	45.9	49.7	46.3	29.9	39.8	13.4
Raw sample	31.8	38.9	30.9	18.5	34.6	6.2
Reject portion of raw sample	68.2	61.1	69.1	81.5	65.4	93.8

Table 5. Silica fraction assay data compared to assumed specifications

Major oxides	Assumed specifications	Silica fraction chemistry (weight percent)					
		Figure 2 sample sites			Figure 3 sample sites		
		1	2	3	4	5	6
SiO_2	>98.0	94.03	94.86	96.71	86.22	85.42	83.36
Al_2O_3	---	5.15	4.51	3.17	10.70	11.39	13.85
TiO_2	---	---	---	---	---	---	---
Fe_2O_3	< 0.04	0.44	0.45	0.44	0.78	0.73	0.72
CaO	---	0.74	0.77	0.73	1.54	1.77	2.28
MgO	---	0.29	0.29	0.27	0.43	0.42	0.47
Na_2O	---	0.37	0.04	---	0.93	1.11	1.23
K_2O	---	0.40	0.37	0.28	0.87	0.75	0.79
SO_3	---	0.24	0.24	0.26	0.26	0.26	0.31
TOTAL	98.04	101.66	101.53	101.86	101.73	101.85	103.01

suitability of these sandstones as a source of silica.

The sandstones need to be tested by flotation to see if as good or better silica product can be produced by this method than by the use of heavy liquids. An in-depth study should cover the various silica sand markets, each with different specifications, and also the markets for the 60 to 70 percent of the sand grains that are rejected from the silica fraction. The reject is mostly clay and feldspar, both of which are used in the ceramic industry. More control is needed in terms of geologic mapping, sampling strategy, lab procedures, and quality control.