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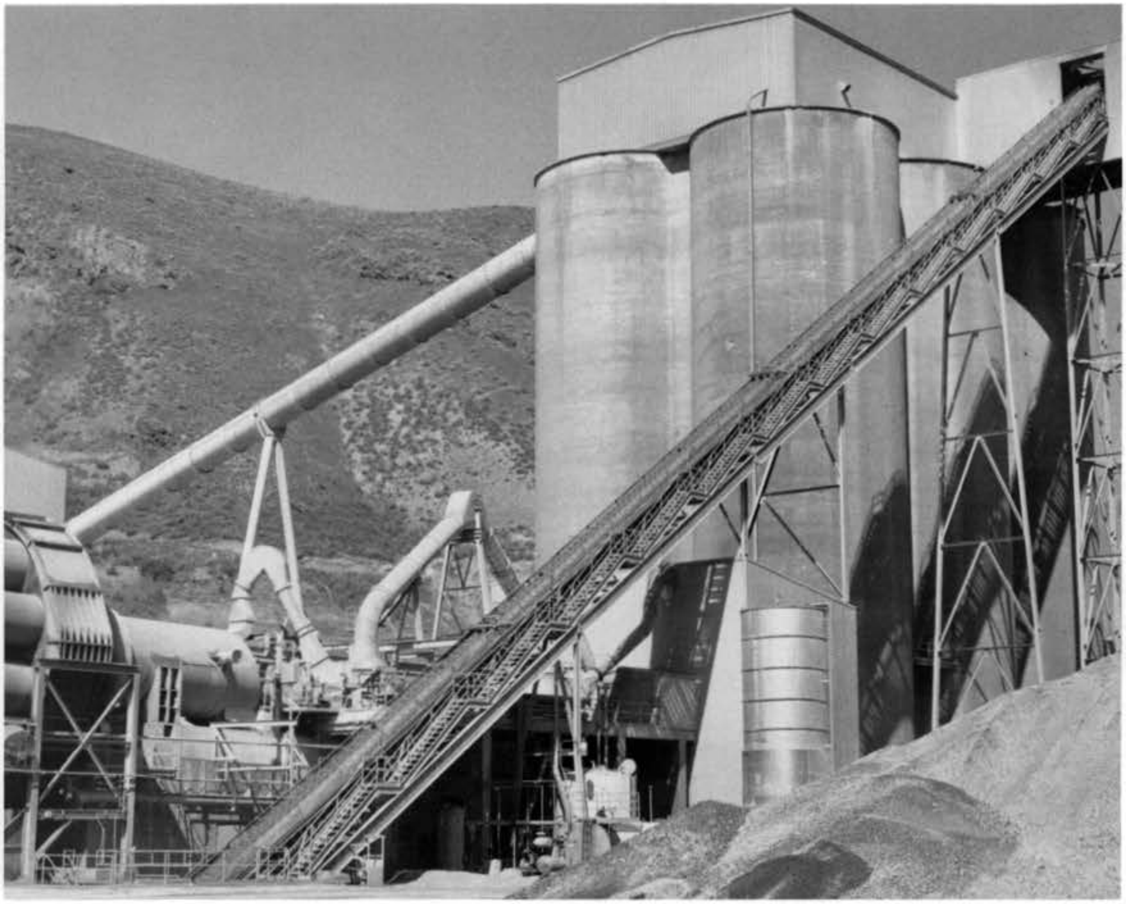

LIMESTONE DEPOSITS IN OREGON

1989

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
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SPECIAL PAPER 19

LIMESTONE DEPOSITS IN OREGON

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COVER PHOTO

Rotary kiln at Ash Grove Cement West, Inc., in Durkee, Baker County. Crushed limestone and shale are calcined (fired) here to produce clinker that is processed into portland cement. This Durkee plant is Oregon's largest producer of portland cement and other limestone products.

LIMESTONE DEPOSITS IN OREGON

Howard C. Brooks

SUMMARY

Oregon's output of crushed and ground limestone (about 40 million tons) has been used mainly in the production of about 18.5 million tons of cement. About 5 million tons have been consumed in lime, sugar, and paper manufacture; in agriculture; and for other miscellaneous uses.

Commercial cement production began in Oregon in 1916. Four cement plants have been built and operated, three by Oregon Portland Cement Company, which is now Ash Grove Cement West, Inc., and one by Ideal Cement Company. Oregon Portland Cement Company operated plants at Lake Oswego near Portland (1916-1982) and at Lime (1923-1980) and Durkee (1979-present) in northeast Oregon. Ideal's plant (1917-1967) was at Gold Hill in southwest Oregon. The Lake Oswego and Gold Hill plants have been dismantled. Output of the Durkee operation has averaged 439,000 tons of cement and 228,000 tons of "sugar rock" annually since 1985.

Oregon's limestone production has come mainly from metamorphosed high-calcium deposits of Paleozoic and Mesozoic age in the Blue Mountains and Klamath Mountains and low-grade deposits of Tertiary age in the Coast Range. Lacustrine carbonate beds and small travertine deposits occur locally in eastern Oregon.

The main limestone units in northeast Oregon are the Martin Bridge Limestone, which is exposed mostly in wilderness areas, and the Nelson Marble. The latter has been and likely will continue to be Oregon's chief source of high-calcium limestone. Its exposure belt in Oregon is about 20 mi long and up to a mile across locally. It contains the Durkee quarry. Several formations contain lenses and blocks of high-calcium limestone. Others include thick sequences of low-grade limestone. The cement quarries at Lime worked deposits in the Weatherby Formation. Chemical-grade lime has been produced from deposits in the Elkhorn Ridge Argillite near Baker and the Hurwal Formation near Enterprise.

In the Klamath Mountains in southwest Oregon, the important limestone deposits are lenses and blocks a few hundred to a few thousand feet in longest dimension in the Applegate Group in the Applegate River area south of Grants Pass and Medford and in the Myrtle Point Formation near Roseburg. Limestone for the Gold Hill cement plant came partly from several small quarries nearby but chiefly from a quarry on Marble Mountain south of Grants Pass. Lime and/or agricultural limestone have been produced from several small deposits in the Applegate River area. Low-grade stone from the Yamhill Formation near Dallas in the Coast Range was used for many years in cement manufacture at the Lake Oswego plant.

Most of the pre-Tertiary deposits are structurally deformed and largely recrystallized. Dolomite deposits are rare. The Nelson Marble and Martin Bridge Limestone are dolomitic locally. Most deposits are gray. Significant quantities of white limestone are limited to currently inaccessible portions of the Martin Bridge Limestone and a couple of small deposits, including the Jones Marble deposit, in southwest Oregon.

INTRODUCTION

INTRODUCTION

This report includes a discussion of most of the limestone-bearing areas in Oregon. Many, but not all, of the individual deposits are described. In several areas where the deposits are small, only a few are described, and they may not be the largest or best grade. Field work for this report was done in the summer months of 1986 and 1987. A total of 289 samples were taken for analysis, and analytical data, maps, and reports were obtained from property owners and operators wherever possible. Some of the information is from unpublished reports contained in the files of the Oregon Department of Geology and Mineral Industries (DOGAMI) field offices in Baker and Grants Pass.

PAST PRODUCTION

Total production of limestone in Oregon was about 40 million tons through 1988. It was used mainly in the production of about 18.5 million tons of cement. About 5 million tons of limestone have been used for other purposes, including the manufacturing of lime, sugar refining, and paper making.

Commercial cement production began in 1916. Four cement plants have been built and operated, three by Oregon Portland Cement Company, which is now Ash Grove Cement West, Inc., and one by Ideal Cement Company and its predecessors, Beaver Cement Company and Pacific Cement Company. Oregon Portland Cement Company operated plants at Lake Oswego near Portland (1916-1982) and at Lime (1923-1980) and Durkee (1979-present) in northeast Oregon. Ideal's plant (1917-1967) was at Gold Hill in southwest Oregon. The Lake Oswego and Gold Hill plants have been dismantled. Bagging facilities remain in use at Lime. Output of the Durkee operation has averaged 439,000 tons of cement and 228,000 tons of "sugar rock" annually since 1985.

Oregon Portland Cement Company operated quarries near Roseburg (1915-1935), Dallas (1915-1967), Lime, and Durkee and cement plants at Lake Oswego, Lime, and Durkee. Ideal Cement Company's quarry was on Marble

Mountain south of Grants Pass, and its cement plant was at Gold Hill. The plant at Lime closed in 1980. Ideal's quarry was deactivated in 1967, and the plant at Gold Hill has been dismantled.

A significant part of the limestone produced from the quarries at Lime, Durkee, and Marble Mountain has been for purposes other than cement, including sugar refining and paper manufacturing.

Deposits whose products have been used mainly to make chemical-grade lime include the Black Marble quarry near Enterprise in the Wallowa Mountains and the Marble Creek and Baboon Creek quarries in the Elkhorn Ridge area near Baker, all in northeastern Oregon. The Horsehead marble quarry and the Muck quarry in the Williams Creek area in southwestern Oregon were small producers of lime rock. Agricultural limestone has been produced from a number of sources, including small quarries in low-grade limestone in the Dallas and Marquam areas in northwest Oregon. According to figures of the Oregon Department of Agriculture, limestone used for agricultural purposes in Oregon in 1979-1988 averaged 105,000 tons annually. Most of this was from sources outside Oregon.

SAMPLING AND ANALYTICAL PROCEDURES

Chemical analyses and brightness tests of samples taken for this report are presented in Table 1 (Plate 1). X-ray diffraction analyses of selected samples are given in the appendix. All of those samples were taken by hand. Most were composed of unweathered chips taken at 10-ft intervals along a selected line. Typical sample length for sufficiently large outcrops was about 100 ft. Grab samples taken of some deposits, particularly small ones, consisted mostly of chips from various parts of the outcrops. Sample weight generally ranged between 5 and 10 lb.

The explanations of the chemical procedures and brightness testing performed by DOGAMI chemist Gary Baxter are presented in the appendix of this report.

TERMINOLOGY

Limestone is a sedimentary rock containing 50 percent or more of detrital or chemically precipitated calcite ($CaCO_3$). The carbonate content is more than 95 percent calcite and less than 5 percent dolomite. Dolomite is also a sedimentary rock, often diagenetically altered, containing 50 percent or more of the mineral dolomite ($CaMgCO_3$) and less than 10 percent calcite.

Dolomitic limestone is intermediate in composition between limestone and dolomite. Calcite has a specific gravity of 2.71 to 2.72 and a hardness of 3. Dolomite has a specific gravity of 2.8 to 2.9 and hardness of 3.5.

Crystalline limestone or dolomite (commonly called "marble") is composed of calcite or dolomite that has been recrystallized, usually as the result of metamorphism. In this report, recrystallized limestone generally is called "limestone" rather than marble. Bioclastic or fossiliferous limestone is composed largely of firmly cemented fossil fragments. Coquina consists mainly of shells and shell fragments.

Cherty or siliceous limestone contains chert as interbeds or secondary (diagenetic) siliceous material in the form of layers, nodules, and veins. Clastic limestone, limestone breccia, and limestone conglomerate consist of recemented fragments of preexisting limestone.

Cement rock refers to impure limestone containing much of the lime, alumina, silica, and iron needed for making portland cement.

Travertine is fine to sometimes coarsely crystalline, dense to vuggy banded rock composed of calcium carbonate that formed from ground water at or near the earth's surface, generally near springs.

Not all deposits consist of a single type of carbonate material. Many contain a mix of two or more of the above types.

USES OF LIMESTONE

Introduction

Limestone and dolomite are among the world's most versatile and widely used mineral commodities. The largest consumers of these rocks and their products are the construction, agricultural, chemical, and metallurgical industries. The total market for crushed limestone and dolomite (excluding about 13.1 million tons of calcareous marl and shells) sold or used in the United States in 1985 was about 716 million tons valued at about $2.75 billion, for an average value of just over $3.84 per ton (Table 2).

Price averages ranged from $2.69 per ton for limestone used to make cement to $18.88 for limestone used in whiting. About two-thirds of the limestone was used because of its physical properties, chiefly in construction as aggregate and fill and for related purposes, but a small amount was also used as an industrial filler. The remainder was used because of its chemical properties as a raw material in the production of portland cement, lime, alkali, calcium carbide, and glass; for flux in metallurgy; for agricultural purposes; and for a large number of minor purposes.

Table 2. *Crushed limestone and dolomite sold or used by producers in the United States in 1985, by use (U.S. Bureau of Mines, 1985). Quantities are in thousand short tons; values are in thousand dollars).*

Use	Limestone		Dolomite	
	Quantity	Value	Quantity	Value
Coarse aggregate (+1-1/2 inch):				
Macadam	11,910	43,974	206	700
Riprap and jetty stone	13,862	51,263	538	1,848
Filter stone	4,677	19,262	93	273
Other coarse aggregate	628	2,902	W	1
Coarse aggregate, graded:				
Concrete aggregate, coarse	68,571	312,520	2,284	8,537
Bituminous aggregate, coarse	42,274	177,932	2,552	10,620
Bituminous surface treatment aggregate	15,321	67,989	919	4,959
Railroad ballast	7,544	28,764	1,896	7,630
Other graded coarse aggregate	677	2,427	--	--
Fine aggregate (-3/8 inch):				
Stone sand, concrete	12,663	58,514	613	3,015
Stone sand, bituminous mix or seal	8,431	32,210	1,026	3,675
Screening, undesignated	10,028	38,737	426	1,618
Other fine aggregate	3,560	12,389	W	W
Coarse and fine aggregate:				
Graded road base or subbase	110,918	369,794	3,400	12,466
Unpaved road surfacing	30,093	110,284	498	1,617
Terrazzo and exposed aggregate	676	4,167	36	197
Crusher run or fill or waste	36,768	139,492	1,214	4,310
Other coarse and fine aggregate	942	3,549	--	--
Other construction materials	8,594	30,007	666	2,194
Agricultural:				
Agricultural limestone	20,637	86,925	1,455	7,936
Poultry grit and mineral food	1,875	15,351	W	W
Other agricultural uses	422	2,024	W	W
Chemical and metallurgical:				
Cement manufacture	91,930	247,826	W	W
Lime manufacture	16,657	64,732	520	1,921
Dead-burned dolomite manufacture	433	4,467	W	W
Flux stone	7,560	31,435	2,717	10,049
Chemical stone	558	2,383	W	W
Glass manufacture	404	3,500	--	--
Sulfur oxide removal	1,427	5,527	32	W
Special:				
Mine dusting or acid water treatment	651	4,057	--	--
Asphalt fillers or extenders	785	4,977	W	25
Whiting or whiting substitute	672	12,687	W	100
Other fillers or extenders	2,978	38,173	373	4,314
Abrasives	302	1,277	--	--
Lightweight aggregate	181	1,319	--	--
Roofing granules	1,993	12,595	2	5
Paper manufacture	640	1,779	--	--
Other miscellaneous uses	8,480	43,985	1,422	6,134
Other unspecified uses[1]	138,289	527,426	8,460	39,132
Total[2]	685,000	2,618,600	31,350	133,300

W=Withheld to avoid disclosing company proprietary data; included with "Special: Other miscellaneous uses."
[1]Includes production without a breakdown by use and estimates for nonrespondents.
[2]Data may not add to totals shown because of independent rounding.

The value and uses of carbonate rocks depend upon their composition. High-quality limestone and dolomite are needed for chemical and metallurgical uses, while less pure stone may be well suited for construction purposes, such as aggregate, fill, and road metal, and for the manufacture of cement.

Construction

Crushed limestone for construction generally is a low-value product (transportation costs commonly exceed the value of the rock itself), but rather stringent specifications usually apply, including such criteria as strength and hardness, cleanliness, abrasion resistance, particle shape, size and size distribution, chemical consistency, and, for some uses, color.

Portland cement

The essential ingredients for the manufacture of portland cement are lime (CaO), silica (SiO_2), alumina (Al_2O_3), and iron oxides (FeO/Fe_2O_3). Most cement is made from limestone, clay or shale, and iron ore, all of which are crushed and blended in the proper proportions. This mix is finely ground and then fed to large rotary kilns, where it is sintered to incipient fusion at about 2,800 °F, forming hard clinkers. The clinker is interground with a small amount of gypsum to a fine gray powder that is portland cement.

Low-grade limestone can be used for making cement as long as the desired ratio of lime to silica, alumina, and iron is maintained. One rigid requirement is that finished portland cement should not contain more than about 5 percent MgO, which requires that the limestone feedstock should not possess more than about 3 percent $MgCO_3$.

At some cement quarries, a substantial fraction of the limestone that is produced is segregated and sold for uses other than cement.

Lime

Leading uses of lime in 1985 were, in decreasing order, steel manufacture, water purification, removal of sulfur from stack gases, manufacture of paper and pulp, and sugar refining, which together accounted for 67 percent of total production. Lime is made by calcining limestone or other calcareous material, usually in lump form, in a kiln at 2,000 to 2,500 °F, which drives off carbon dioxide (CO_2). Theoretically, pure limestone would lose 44 percent of its weight in the calcining process. Since no limestone is pure, the actual weight loss is somewhat less, depending on the amount of impurities present. During calcining, the weight of impurities is unchanged, and their proportion of the resulting lime is nearly doubled. Also, some impurities react with calcium oxide and thereby reduce its availability. Because the value of lime depends largely upon its available lime (CaO) content, the purity of the limestone is a crucial factor in evaluating limestone deposits for lime production.

Agricultural limestone

Limestone and dolomite are ground and added directly to soils or are added to other fertilizers for one or more of the following: to replenish calcium and magnesium, to correct acidity, to improve physical conditions, and to increase the benefits and availability of other elements essential to soil fertility.

Industrial fillers, extenders, and whiting

Limestone and dolomite, usually of high quality and very finely ground, are used as fillers, extenders, and mineral pigments in a wide variety of products, including plastics, paint, rubber, floor coverings, adhesives, and paper. The stone used, particularly for whiting, must possess special characteristics, including good white color and a high degree of reflectivity, no abrasive impurities, minute particle sizes (10 microns and less), and the capacity for absorbing large amounts of oil, ink, and color pigments.

Paper

Calcium carbonate, in the form of either finely ground limestone or precipitated calcium carbonate, is used as sizing (surfacing) and filler in the alkaline paper-making process. Presently, most domestic paper manufacturing plants use the acid process, but some authorities predict that the number of plants employing the alkaline process will increase appreciably within the next ten years.

Sugar manufacture

Sugar refining consumed about 557,000 tons of lime in 1985. In most refineries, limestone is burned to produce lime and carbon dioxide. The lime is mixed with the juice from the sugar beets or cane to precipitate colloidal matter so the juice can be concentrated. Later in the process, the carbon dioxide that was given off in the burning process is bubbled through the juice mixture to precipitate the lime as insoluble calcium carbonate. This sludge includes coagulated and other material and is removed in a filtration process. The filter cake from this process is discarded.

Cyanidation of gold ores

A growing amount of lime is being used in the processing of low-grade gold ores by heap-leach cyanidation. Lime is used for controlling pH in the leach operation and subsequent reclamation of tailings. Basic conditions must be maintained to prevent the generation of poisonous hydrogen cyanide gas. The lime is mixed with the ore during delivery to the leach pad at the rate of 3 to 5 lb of lime per ton of ore.

ACKNOWLEDGMENTS

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Virtue Hills and freely contributed information from their paleontologic research in those areas; Richard Cooke, Edmond Miller, David Beedle, Jack Yeates, and R.E. Corcoran, for providing information about properties owned by Oregon Portland Cement Company and Ash Grove Cement West, Inc.; L.W. Staples and E.M. Baldwin, for information about limestone deposits near Dallas; and Norman Peterson, for allowing use of his unpublished work on limestone deposits in southwestern Oregon. The writer is indebted to Len Ramp, Edmond Miller, John Beaulieu, and Ron Geitgey for critically reviewing the manuscript prior to publication and to secretary Janet Durflinger for her infinite patience in helping prepare the manuscript. DOGAMI staff who prepared the manuscript for final publication include Dian Goldsmith, who worked on the data tables; Beverly Vogt and Klaus Neuendorf, who edited the manuscript and prepared camera copy for publication; and Mark Neuhaus, who prepared the maps and figures.

LIMESTONE DEPOSITS

INTRODUCTION

The limestone deposits in Oregon are concentrated in the Blue Mountains, Klamath Mountains, and Coast Range geomorphic provinces in the northeastern, southwestern, and northwestern parts of Oregon, respectively (Figure 1). Historically, the largest production has been from deposits in Baker County in the Blue Mountains, followed by deposits in Polk County in the Coast Range and in Josephine and Douglas Counties in the Klamath Mountains.

All of the productive deposits in the Blue Mountains and Klamath Mountains are associated with marine sedimentary and volcanic rocks of late Paleozoic and Mesozoic age. Those in northwestern Oregon are in marine sedimentary rocks of Tertiary age. Undeveloped deposits in south-central Oregon are in Tertiary fresh-water sedimentary rocks. The high-calcium deposits are in formations of Paleozoic and Mesozoic age in northeastern and southwestern Oregon. Although some of the Tertiary deposits in northwestern Oregon have been highly productive, the limestone is impure, with most of it containing less than 60 percent $CaCO_3$.

Locations of all limestone deposits discussed in this study are shown on Figure 2 (Plate 2). Locations and analytical data of limestone deposits sampled for this report are given in Table 1 (Plate 1). Limestone areas are designated by letters, and localities within the areas are designated by area letter plus a locality number (for example, since Paddy Creek is the first locality in the southern Wallowas [area C], it is locality C-1).

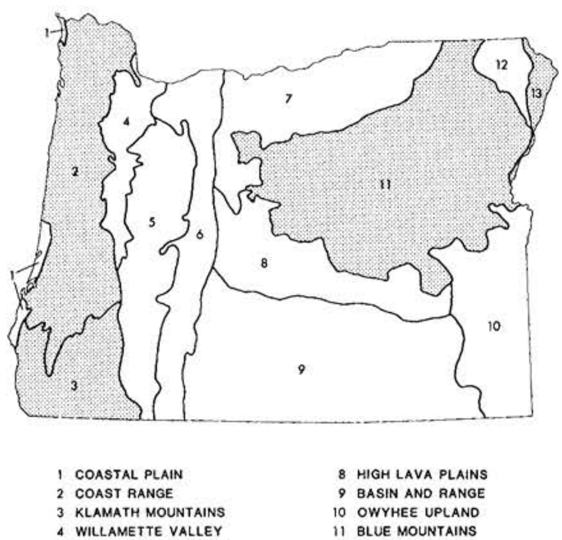

Figure 1. Map showing geomorphic provinces in Oregon. Provinces containing marine limestone deposits are shaded.

Most carbonate deposits in Oregon are limestone. The only known deposits of dolomite include the Bristol deposit in the Gold Hill area in the Klamath Mountains of southwestern Oregon and a few small dolomite and dolomitic limestone deposits in the Grindstone terrane in the Blue Mountains. Parts of the Nelson Marble and Martin Bridge Limestone, also in the Blue Mountains, are dolomitic to the extent of being unusable for making cement. The low-grade lacustrine carbonate deposits in the Tenmile Ridge area north of Paisley contain about 25 percent CaO and 13 percent MgO. Samples of Tenmile Ridge deposits also contain anomalous amounts of strontium. Otherwise, analytical results in Table 1 (Plate 1) show no significant amounts of elements atypical of limestones in Oregon. X-ray diffraction studies of the insoluble residue of some samples done by Ronald Geitgey showed expected mineralogy (see appendix).

Most of the large, high-calcium limestone deposits in Oregon have undergone dynamic and thermal metamorphism, and the resulting recrystallization largely destroyed textures, structures, and fossils of the original rock and converted the carbonate material to crystalline calcite or calcite and dolomite. Color banding or mottling developed locally. Banding typically parallels original bedding or foliation planes, and individual bands range from a few millimeters to several centimeters thick. The color variations probably are due to uneven redistribution of organic material during metamorphism.

Whereas pure calcite or dolomite are white or colorless, the average color of most Oregon limestone deposits is some shade of gray, due largely to the presence of small quantities of carbonaceous material. Notable exceptions are the Black Marble deposit, which is nearly black, and the Jones Marble deposit, which is white to light gray. Both of these deposits are a few million tons in size. Many crystalline limestone deposits contain small patches of white or light-gray limestone and areas of banded or mottled white and gray limestone.

Presently, the only large limestone-producing operation in Oregon is Ash Grove Cement West, Inc., at Durkee. Small amounts of limestone for agricultural use are produced intermittently from a few other deposits.

RESERVES

Reserves of high-calcium limestone in Oregon are mainly in the Martin Bridge Limestone and Nelson Marble in the Blue Mountains. Most of the large, good-quality limestone exposures of the Martin Bridge Limestone are inaccessible because they are in wilderness areas. The Nelson Marble has been for many years and will likely continue to be the chief source of limestone in the state. It is exposed in a 20-mi-long belt in Oregon, which, in the Durkee-Fox Creek area, is nearly a mile wide. Because of its remote location, the only portion that has been developed is the Durkee quarry, operated by Ash Grove Cement West, Inc. Extensive surface sampling and some drilling indicate enormous reserves of good-quality limestone in the Durkee-Fox Creek area.

Other deposits in eastern Oregon having significantly large reserves are those containing the Baboon Creek, Marble Creek, and Black Marble quarries. The Juniper Mountain deposit is unexplored but may contain a moderately large amount of good-quality limestone.

Reserves in southwest Oregon are limited mainly to a few deposits containing more than a million tons each, including the Marble Mountain and Muck quarries and the Jones Marble deposit. Several smaller deposits could be utilized for purposes for which capital costs are not large, such as agricultural lime production.

In northwest Oregon, the Rickreall Member of the Yamhill Formation contains large quantities of low-grade limestone.

NORTHEASTERN OREGON, BLUE MOUNTAINS PROVINCE

Introduction

The largest deposits of high-calcium limestone in Oregon are in the Blue Mountains geomorphic province in the northeastern part of the state. The deposits lie principally in Baker and Wallowa Counties in the eastern part of the region, but there are small, scattered occurrences in parts of Grant, Malheur, Crook, and Harney Counties. The terrane is mostly mountainous but includes areas of rolling hills and fertile valleys. Population is sparse. The eastern part of the region is crossed by a major freeway (Interstate I-84) and the Union Pacific Railroad. State highways connect the larger valleys. The more remote areas are served by graveled county roads and roads built for logging and access to scattered ranches.

The limestone deposits are associated with a broad belt of exposures of pre-Cenozoic volcanic, intrusive, and sedimentary rocks that were accreted to the North American continent in Late Jurassic-Early Cretaceous time. This belt extends from the Seven Devils region in Idaho southwesterly across the Snake River nearly to the middle of Oregon. The rocks probably formed in island-arc and associated arc-basin and oceanic-crust plate-tectonic settings. They have been divided into five petrotectonic terranes, shown in Figure 3, that were initially defined in a series of papers by Brooks and Vallier (1978), Dickinson and Thayer (1978), and Dickinson (1979). Nomenclature used in Figure 3 is that proposed by Silberling and others (1984).

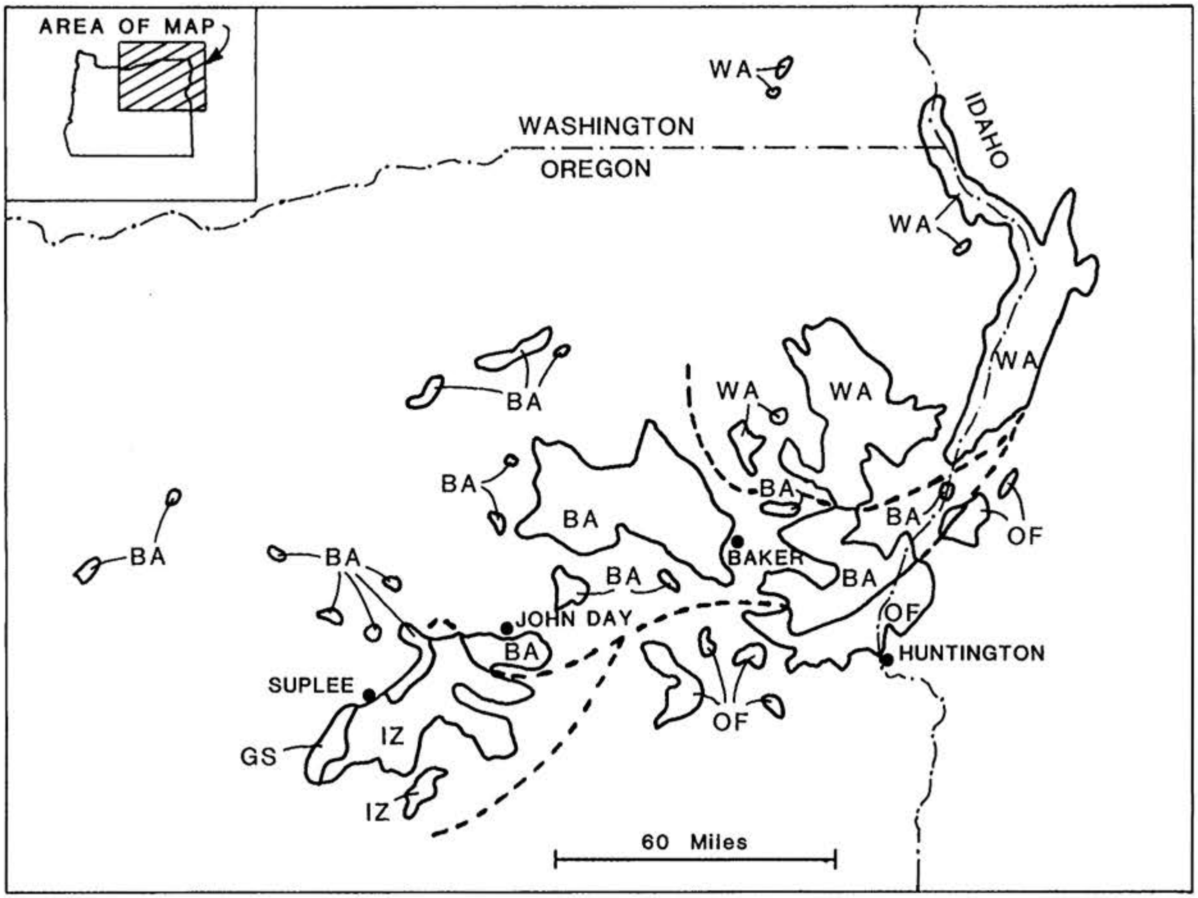

Figure 3. Map showing distribution of pre-Tertiary rocks and generalized petrotectonic terrane boundaries for the Oregon part of the Blue Mountains province. WA = Wallowa terrane; BA = Baker terrane; OF = Olds Ferry terrane; IZ = Izee terrane; and GS = Grindstone terrane. Modified from Silberling and others, 1984.

Limestone deposits are discussed in this report by terrane and by formation and/or areas within each terrane. The discussion progresses geographically from northeast to southwest across the Wallowa, Baker, Olds Ferry, Izee, and Grindstone terranes. Limestone-bearing units in the various terranes in the Blue Mountains are shown in Table 3.

Limestone is the major constituent of the Nelson Marble in the Baker terrane and the Martin Bridge Limestone in the Wallowa terrane. In all of the other units listed, limestone is a minor, though locally important, component occurring mainly as pods, lenses, and discontinuous interbeds associated with other types of sedimentary rocks.

Major producers

The major limestone-producing quarries in the Blue Mountains are listed in Table 4.

The Durkee quarry, which began operating in 1954 and is presently active at the rate of about 800,000 tons per year, is operated by Ash Grove Cement West, Inc. Limestone from the Lime and Durkee quarries was processed into cement at a plant at Lime from 1923 to 1980. A new cement plant at the Durkee site began operating in 1979. Output of the Marble Creek and Baboon Creek quarries was used to produce more than 347,000 tons of lime at a plant 5 mi north of Baker. The quarries are in the Elkhorn Ridge area to the west. The Black Marble quarry in the northern Wallowas near Enterprise, which also produced limestone for lime manufacture, was active at intervals between 1925 and 1961.

Wallowa terrane deposits

In the Oregon portion of the Wallowa terrane, limestone deposits occur in the Wallowa Mountains, the Snake River canyon north of Oxbow, and the Keating-Medical Springs area in the southern foothills of the Wallowa Mountains (Table 5). Parts of Baker, Wallowa, and Union Counties are included in this terrane.

Most of the limestone exposures in the Wallowa terrane are part of the Martin Bridge Limestone. A few small deposits occur as interbeds and lenses in the overlying Hurwal Formation and underlying volcanic and volcaniclastic rocks.

Martin Bridge Limestone underlies more than 50 mi^2 of the surface in the northern Wallowas and 10 mi^2 in Hells Canyon. Thickness estimates range from 825 ft (Follo, 1986) and 1,500 ft (Ross, 1938) in the southern and northern Wallowas to 1,700 ft in the Snake River canyon (Vallier, 1977). Much of the limestone is good quality, but, with the exception of the Black Marble deposit, there has been very little production from any of the deposits because the area is rugged topographically and far removed from major markets and lines of transportation. The larger deposits are in wilderness areas.

Exposures of the Martin Bridge Limestone in the northern Wallowas and Hells Canyon consist mostly of recrystallized limestone, while exposures in the south part of the range include a large proportion of clastic rocks. Follo (1986) suggested that these facies differences are products of the diverse depositional processes that characterize a carbonate platform environment in the northern Wallowas and Hells Canyon and slope and basin environments in the southern Wallowas.

Northern Wallowas

Distribution of the Martin Bridge Limestone in the northern Wallowas is shown in Figure 4. Elevations of limestone exposures in the northern Wallowas range from about 4,000 to 9,000 ft. The central part of the range is exceptionally scenic, and that area (345 mi^2) has been set aside as the Eagle Cap Wilderness.

Most of the Martin Bridge Limestone and associated

Table 3. *Limestone-bearing units in various terranes in the Blue Mountains. Units are listed by terrane. Position in table does not imply correlation or age equivalency.*

Wallowa terrane	Baker terrane	Olds Ferry terrane	Izee terrane	Grindstone terrane
Hurwal Formation	Nelson Marble	Weatherby Formation	Begg Formation	Coffee Creek Formation
Martin Bridge Limestone	Burnt River Schist	Huntington Formation	Brisbois Formation	Coyote Butte Formation
Seven Devils Group	Elkhorn Ridge Argillite		Graylock Formation	
Clover Creek Greenstone			Robertson Formation	
			Snowshoe Formation	
			Murderers Creek Graywacke	
			Rail Cabin Argillite	

Table 4. *Limestone-producing quarries in the Blue Mountains.*

Quarry name	Year operated	Production (tons)	Main use	Formation
Durkee	1954-present	600,000	Cement	Nelson Marble
Lime	1923-1965	9,020,000	Cement	Weatherby Formation
Marble Cr.	1957-1963	350,000	Lime	Elkhorn-Ridge Argillite
Baboon Cr.	1963-1971	275,000	Lime	Elkhorn-Ridge Argillite
Black Marble	1925-1961	275,000	Lime	Martin-Bridge Limestone

Table 5. *Rock units in various parts of the Wallowa terrane.*

Snake River Canyon	Wallowa Mountains	Medical Springs Keating area
Columbia River Basalt Group (Miocene)	Columbia River Basalt Group (Miocene)	Basalt (Miocene)
--	Hurwal Formation (Upper Triassic -Jurassic)	--
Martin Bridge Limestone (Upper Triassic)	Martin Bridge Limestone (Upper Triassic)	--
Doyle Creek Formation (Upper Triassic)	--	--
Wild Sheep Creek Formation (Upper Triassic)	Lower Sedimentary Ser. (Upper Triassic -Permian)	Clover Creek Greenstone (Upper Triassic -Permian)
Hunsaker Creek Formation (Permian)	Clover Creek Greenstone (Upper Triassic -Permian)	--
Windy Ridge Formation (Permian)	--	--

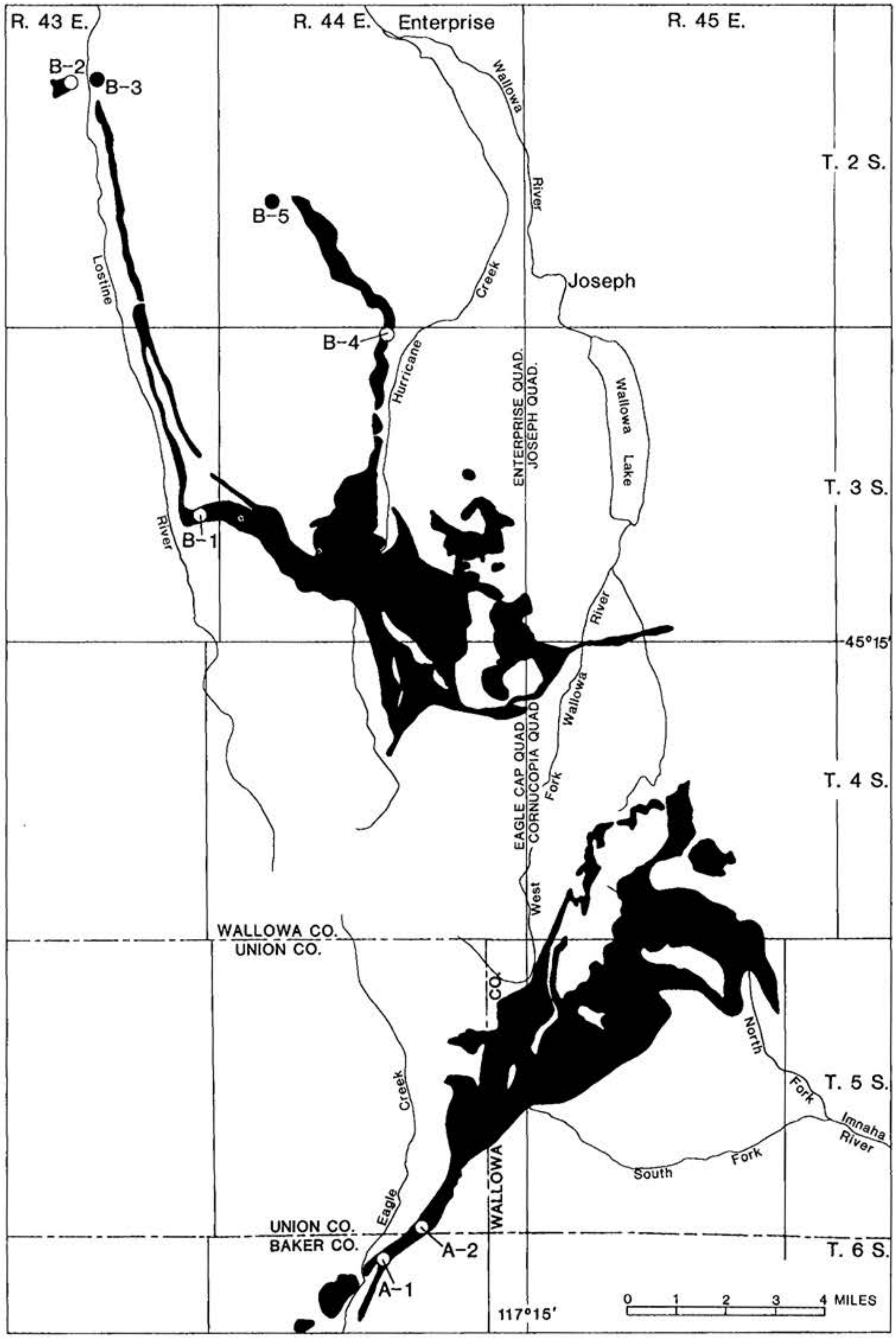

Figure 4. Map of part of the northern Wallowa Mountains showing distribution of limestone deposits (solid areas). Localities A-1 and -2 and B-1 through -5 are also shown. Adapted from a map compilation by Weis and others, 1976.

strata have been affected by emplacement of the Wallowa batholith. As described by Weis and others (1976), the intruded rocks within a few hundred feet of the contact are metamorphosed and for distances of 1 to 3 mi are severely deformed. Large-scale folds are common; some, for example, along East Eagle Creek, are overturned.

The limestone in most exposures is recrystallized, light gray to white, and typically massive or banded. Banding usually is defined by segregations of carbonaceous matter and, in most places, parallels original bedding and weak foliation. The width of the gray and white bands typically varies from less than an eighth of an inch to 1 in. The gray bands generally are thinner than the white.

In several areas, limestone near the batholith has been altered to skarn containing epidote, garnet, quartz, and, locally, small amounts of copper, tungsten, molybdenum, and gold (Oregon Department of Geology and Mineral Industries, 1939; Wolfe and White, 1951). None of the metallic mineral deposits have been productive.

East Eagle Creek area (area A):

A well-exposed belt of Martin Bridge Limestone in the East Eagle Creek drainage (Figure 4) was sampled in two places that are briefly described below. Average width of the belt measured on a map is about 1,200 ft. Figure 5 shows an exposure of the limestone in sec. 4, T. 6 S., R. 43 E.

Bedding approximately parallels the trend of the belt and dips 50° to 60° SE. The geologic section is overturned, and the limestone is now overlain by volcanic and volcaniclastic rocks of Triassic age and underlain by clastic rocks of the Hurwal Formation.

Two areas (Weis and others, 1976) sampled in the Eagle Cap Wilderness area are not accessible by road. A road up East Eagle Creek ends at the Wilderness boundary about 45 mi from Baker.

The Box (locality A-1): Location: NE¼ sec. 3 (projected), T. 6 S., R. 44 E., about 1,500 ft east of East Eagle Creek and 1,500 ft north of a creek called The Box. Eagle Cap 15-minute quadrangle.

Owner: U.S.D.A. Forest Service (USFS), Eagle Cap Wilderness.

Six chip samples (AUB-72 through -77, Table 1, Plate 1) were taken across the strike of the lower part of the exposed belt beginning at about 5,600-ft elevation and extending to about 5,800-ft elevation. The limestone here contains many fragments of metamorphosed clastic sedimentary rock, mafic volcanic rock, and a few mafic dikes. The noncarbonate bodies range from a few inches to 50 ft in longest dimension. They are widely distributed. Because of the size variation, their overall volume relative to that of the limestone is difficult to estimate but may be about 10 percent. Except for the presence of these rock fragments, the limestone is quite pure.

Figure 5. Martin Bridge Limestone, East Eagle Creek area (area A).

The limestone varies from gray to white and is light gray overall. White or light-gray rock with thin gray banding is common.

Curtis Creek (locality A-2): Location: SW¼ sec. 35 (projected), T. 5 S., R. 44 E., on the north side of Curtis Creek, a tributary on the east side of East Eagle Creek. Eagle Cap 15-minute quadrangle.

Owner: USFS land, Eagle Cap Wilderness.

Twelve samples (AUB-114 through -125, Table 1, Plate 1) were taken along the ridge north of Curtis Creek extending upward (southeasterly) from 6,320-ft to 6,720-ft elevation and across the strike of the limestone. The limestone has a map width of about 1,000 ft. It varies from light gray to white and is mostly coarsely crystalline and commonly friable. Locally, it crumbles when struck with a hammer. Alternating gray and white color banding parallel to bedding is common.

Lostine River and Hurricane Creek area (area B):

A narrow belt of Martin Bridge Limestone is exposed along the east wall of Lostine River Canyon for about 8.5 mi. It extends from the northern part of sec. 10, T. 2 S., R. 43 E., 6 mi south of Lostine, south to the southern edge of sec. 24, T. 23 S., R. 43 E. From the latter area, the limestone belt turns and trends eastward through Marble Point and across Hurricane Divide interconnecting with exposures in the high Wallowas. A small body of Martin Bridge Limestone is exposed on the west side of the Lostine River in secs. 9 and 10, T. 2 S., R. 43 E. Samples were taken for this report from the latter exposure and from a site near Marble Point.

As mapped by Weis and others (1976), the limestone is both overlain and underlain by clastic sedimentary rocks of the Hurwal Formation. The Hurwal Formation under the limestone is interpreted as overturned. Bedding in the limestone parallels the trend of the belt and dips northeast.

The Martin Bridge Limestone is exposed also in a narrow north- to northwest-trending belt along the west side of the lower part of Hurricane Creek canyon and continues along the mountain front to the northwest. Here the section is upright, and the limestone is about 960 ft thick between the underlying volcanic rocks and the overlying Hurwal Formation. Nolf (1966) informally divided the limestone in this belt into two stratigraphic members each 410 to 480 ft thick: the lower is the Hurricane Creek member, and the upper is the Scotch Creek member.

Nolf (1966) and Follo (1986) describe the Hurricane Creek member as very pure, usually recrystallized, and massive or thick bedded, weakly foliated, and nonfossiliferous. They describe the Scotch Creek member as composed of silty, carbonaceous limestone containing a substantial fraction of silt-sized and finer clastic material. Bedding ranges from less than 4 in. to 6 ft thick. Some beds are richly fossiliferous.

Marble Point deposit (locality B-1): Location: W½SE¼ sec. 24, T. 3 S., R. 43 E., on the Marble Point ridge at about 6,740-ft elevation. Enterprise 15-minute quadrangle.

Owner: USFS land, Eagle Cap Wilderness.

Access to the sample site is provided by the Francis Lake trail, which starts near Lapover Ranch. Eleven chip samples (AVB-49 through -59) were taken for analysis. Results are given in Table 1 (Plate 1). The sample line followed the slope contour beginning at the north edge of the limestone exposure and extending southward. The sample interval was about 200 ft.

The limestone is crystalline and white to gray in color. Color banding, bedding, and poorly developed foliation are approximately parallel, strike east-west, and dip 45° S.

Lower Lostine (locality B-2): Location: Secs. 9 and 10, T. 2 S., R. 43 E., on the west side of the Lostine River 6 mi south of Lostine. Enterprise 15-minute quadrangle.

Owner: Sec. 9 is USFS land. Exposures in sec. 10 are privately owned in part by Jack McGoldrick.

A kiln 25 ft square at the base and 30 ft high built of rock many years ago remains on the property. Apparently, it was used very little. Moore (1937) reported that a quarry was opened, and "considerable amounts of limestone were burned for quicklime for local consumption." The kiln was in ruins at the time of his visit. No quarry site was identified. A few hundred tons of lime remain piled near the kiln.

The deposit is a well-exposed block of Martin Bridge(?) limestone about 2,400 ft long and 1,400 ft wide. The slope is steep, and limestone bluffs are common.

The limestone is crystalline, mostly massive, and medium to light gray. A minor amount is nearly white. Bedding in one area strikes N. 50° E. and dips 65° NW.

Samples AVB 60- through -64 (Table 1, Plate 1) represent various parts of the deposit.

Starlite Mine (locality B-3): Location: Sec. 10, T. 2 S., R. 43 E., on the east side of the Lostine River opposite the Lower Lostine deposit. Enterprise 15-minute quadrangle.

Owner: Not determined.

The deposit is a small block of Martin Bridge Limestone that has slid to its present position near the valley floor beneath the belt of Martin Bridge Limestone exposed on the slope above.

During the late 1950's, Harold Glenn shipped two carloads of limestone from it, one to the sugar factory at Nyssa and one to a paper plant in Washington. The rock is said to have been of good quality, but the expense of mining and transportation exceeded the value of the product.

Wallowa Cement and Lime Company property (locality B-4): Location: Secs. 3, 9, 10, 15, and 16, T. 3 S., R. 44 E., on the west side of Hurricane Creek. Enterprise 15-minute quadrangle.

Owner: The property consists of 470.79 acres of patented mining claims owned by Wallowa Cement and Lime Company (87.5 percent) and Drake University (12.5 percent).

There is no record of development. Mineral rights to bottom lands in parts of secs. 15, 22, 27, 28, and 33 were relinquished to the USFS in the early 1960's. The limestone exposures are on a slope so steep that development would be difficult. None are accessible by road.

Black Marble quarry (locality B-5): Location: Secs. 19 and 20, T. 2 S., R. 44 E., in the upper part of Murray Creek about 7.2 mi by road southwest of Enterprise at about 5,900-ft elevation. Enterprise 15-minute quadrangle.

Owner: Wallowa Company (Charles B. Coyne).

The deposit is on the steep, forested northeast slope of the Wallowa Range. A small amount of development work had been done by the Oregon Black Marble Company prior to Parks' (1914, p. 30) visit in 1914. The Black Marble and Lime Company acquired the property in 1925. A plant utilizing three stack kilns having a total capacity of 10,000 tons of lime per year was built about 1 mi west of Enterprise and 5½ mi from the mine and by June 1931 had produced about 7,000 tons (Moore, 1937, p. 131). The company name was changed later to Northwest Lime Company. All of these early operations were short lived, and it is unlikely that total production exceeded 10,000 tons.

The Enterprise Lime Company operated the quarry for short periods during the mid-1930's and late 1940's with the assistance of a government loan. Greely Lime Company, a subsidiary of Pacific Carbide and Alloys Corporation, purchased the property from the Reconstruction Finance Corporation in 1949 and operated the quarry from 1950 to 1961. Most of the stone was used in making calcium carbide at Pacific's plant in Portland. Fine sizes were marketed for agriculture stone in the Willamette Valley and southwest Washington. According to Marshall Okell (personal communication, 1987), former Vice President of Pacific Carbide and Alloys, quarry production averaged about 25,000 tons per year, with a total production of 275,000 tons. Production in 1958, 1959, and 1960 was 17,658 tons, 23,621 tons, and 19,650 tons, respectively. The rock was transported from the plant to Portland by rail.

The quarry is half-moon shaped in plan (Figure 6). The face is nearly vertical and about 600 ft long and 200 ft high. The quarry develops a small limestone body that is an isolated block structurally and stratigraphically separated from the Martin Bridge Limestone and is lithologically different from any known limestone in the region. It was regarded by Smith and Allen (1941) as part of the Martin Bridge Formation, by Nolf (1966) as a slide block from an unknown source, and by Weis and others (1976) as part of the Hurwal Formation. Prior to mining, the exposure was about 1,000 ft long, 50 to 500 ft wide from east to west, and up to 500 ft thick (Parks, 1914). Associated rocks are dark-colored graywacke and mudstone. A thick sequence of basalt flows of the Miocene Columbia River Basalt Group overlies rocks of the Hurwal Formation less than a quarter of a mile above the quarry. Individual limestone beds range from 1 ft to 6 ft or more in thickness. Bedding strikes about N. 35° W., nearly paralleling the contour of the slope, and dips 10°-15° SW. Nearly vertical joints cut the limestone beds at intervals ranging from 2 to 6 ft.

The limestone is massive and sooty black in color, with small veinlets and patches of white calcite. Some of the white patches are fossil remains. The chemical quality is good for most limestone uses. The calcined stone is white, indicating

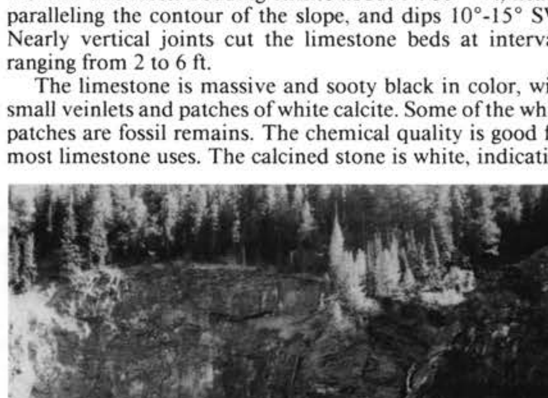

Figure 6. Black Marble quarry (locality B-5), Lostine River-Hurricane Creek area.

that the dark color of the fresh rock is due to organic material. Some of the stone is quite attractive when polished but is not known to have been used extensively for building and decorative purposes.

Samples AVB-77, -78, and -79 (Table 1) were taken along the foot of the quarry face from west to east and represent 0- to 100-ft, 200- to 300-ft, and 400- to 500-ft intervals, respectively.

Some diamond core drilling was done, but most of the data regarding it have been lost. Records of two holes were made available by Mr. Okell. Hole number 1, dated 4-24-54, was 310 ft deep. The other, marked drill-hole number 4 and dated 11-14-57, was 250 ft deep. Both bottomed in limestone. Although the exact locations of these holes are unknown, analytical results given in Table 6 indicate the consistency of the deposit. The analyses were run by Laucks Testing Laboratories, Seattle, Washington, in May 1954.

Table 6. *Chemical analyses of drill-hole samples, Black Marble quarry (locality B-5), Lostine River and Hurricane Creek area. Analyses by Laucks Testing Laboratories, Seattle, Washington, in May 1954. All values are in weight percent.*

Hole 1 (ft)	LOI	CaO	$CaCO_3$	SiO_2	R_2O_3	MgO	$MgCO_3$	P
0-5	43.12	54.95	98.08	0.65	0.62	0.31	0.65	0.009
20-25	43.20	54.73	97.69	1.03	0.95	0.17	0.36	0.012
40-45	43.12	54.52	97.31	1.60	0.60	0.24	0.50	0.009
60-65	43.48	53.93	96.27	0.61	0.93	1.05	2.20	0.019
80-85	43.32	54.71	97.65	0.64	0.98	0.35	0.73	0.008
100-105	43.20	54.88	97.96	0.74	1.08	0.06	0.12	0.009
120-125	43.45	54.92	98.03	0.63	0.67	0.28	0.59	0.008
140-145	43.60	55.09	98.33	0.48	0.58	0.29	0.61	0.007
160-165	43.70	53.02	94.64	0.41	0.89	1.95	4.08	0.019
180-185	43.76	51.54	91.99	0.70	0.96	3.04	6.36	0.009
200-205	43.67	49.37	88.12	0.80	1.65	4.50	9.41	0.018
220-225	43.60	53.90	96.21	0.81	1.24	0.34	0.71	0.014
240-245	43.42	53.50	95.49	0.80	0.97	1.31	2.74	0.022
260-265	42.90	52.50	93.67	1.20	1.97	1.39	2.91	0.022
280-285	43.40	54.95	98.08	0.72	0.67	0.26	0.54	0.010
300-305	43.60	54.77	97.76	0.67	0.48	0.52	1.09	0.012
305-310	43.35	54.44	97.17	0.70	0.93	0.56	1.17	0.016

Hole 4 (ft)	LOI	CaO	MgO	SiO_2	R_2O_3	P
4-10	--	53.88	1.04	1.10	0.22	0.0045
10-15	--	53.49	0.81	0.59	0.22	0.005
15-20	--	54.27	0.80	0.38	0.11	0.0036
20-25	--	54.20	0.74	0.62	0.14	0.0045
25-30	--	52.32	1.09	2.78	0.22	0.004
30-35	--	53.24	1.32	0.85	0.13	0.0036
35-40	--	54.09	0.67	0.46	0.10	0.0027
40-45	--	54.05	0.76	0.84	0.13	0.0045
45-50	--	53.77	0.98	0.81	0.14	0.005
50-55	--	53.53	0.96	0.83	0.15	0.0046
55-60	--	54.20	0.87	0.50	0.06	0.0036
60-65	--	33.90	0.71	0.99	0.13	0.0045
65-70	--	50.27	1.12	5.04	0.63	0.005
70-75	--	53.38	0.92	1.08	0.13	0.004
75-80	--	53.39	1.01	0.46	0.10	0.0036
80-85	--	53.82	0.51	1.06	0.10	0.004
85-90	--	52.10	1.30	3.06	0.24	0.006
90-95	--	49.52	3.17	3.84	0.90	0.006
95-101	--	53.61	0.96	0.60	0.15	0.004
101-105	--	54.39	0.50	0.19	0.07	0.004
105-110	--	53.95	0.89	0.38	0.14	0.0045
110-115	--	54.29	0.89	0.27	0.12	0.004
115-120	--	54.68	0.91	0.15	0.08	0.0036
120-125	--	53.47	0.92	0.96	0.22	0.002
125-130	--	54.47	0.82	0.21	0.10	0.0023
130-135	--	54.26	0.97	0.30	0.09	0.002
135-140	--	53.45	1.15	1.37	0.11	0.0022
140-146	--	53.91	0.71	0.31	0.13	0.004
146-151	--	50.07	2.46	3.77	1.06	0.004
151-156	--	53.86	0.97	0.74	0.44	0.002
156-161	--	52.10	1.22	2.35	0.15	0.002
161-166	--	53.05	1.02	0.73	0.23	0.002
166-171	--	51.85	2.04	1.75	0.38	0.004
171-176	--	53.64	1.21	0.52	0.46	0.002
176-181	--	54.13	0.82	0.28	0.13	0.003
181-186	--	53.41	0.88	0.84	0.40	0.005
186-191	--	53.90	1.20	1.00	0.23	0.007
191-196	--	53.25	1.42	1.27	0.14	0.008
196-201	--	54.13	1.07	0.34	0.12	0.006
201-206	--	53.12	1.37	1.42	0.32	0.005
206-211	--	53.64	0.94	0.75	0.15	0.0045
211-216	--	53.34	0.77	1.27	0.37	0.007
216-221	--	53.58	0.90	0.36	0.14	0.003
221-226	--	53.51	0.90	0.31	0.11	0.004
226-230	--	54.22	1.22	0.62	0.13	0.004
230-233	--	clay	--	52.5	--	0.007
233-236	--	25.04	7.52	29.86	12.00	0.009
236-241	--	53.10	0.93	1.90	0.76	0.007
241-246	--	51.87	1.27	1.91	0.27	0.005
246-250	--	53.59	0.85	0.61	0.15	0.0045

Officials of Pacific Carbide and Alloys Company estimated reserves to be at least 3 million tons. Total vertical depth of the deposit and its extent into the mountain are unknown. Because the deposit dips 10° S. into the mountain, the amount of overburden to be removed increases as the quarry face is advanced. In order to start another series of benches, up to 50 ft of stripping will be required.

Southern Wallowas (area C)

The southern Wallowas include the limestone in a small area in the southern part of the range that drains southward into Eagle Creek, including the deposits along East Eagle Creek, Goose Creek, and Paddy Creek, and along Eagle Creek between East Eagle Creek and Basin Creek.

The Martin Bridge Limestone in the southern Wallowas includes interbedded calcareous and noncalcareous, locally carbonaceous shale, argillite, and siltstone; fine-grained, thinly laminated limestone; well-bedded carbonate grainstone and packstone; and massive carbonate-clast conglomerate.

Fine-grained, thin-bedded clastic rocks underlie more than 80 percent of the area mapped as Martin Bridge Formation by Ross (1938) and Prostka (1962). Less than half of these clastic rocks are calcareous. The calcareous and noncalcareous clastic rocks are interbedded and difficult to distinguish. Some of the carbonaceous layers are rich in fossil fragments. Limestone beds and lentils are widely distributed but make up less than 10 percent of the rock exposed. The limestones occur as interbeds less than 1 in. to several tens of feet thick interbedded with clastic rocks. Most of the carbonate rocks are dark gray on fresh surfaces and weather medium gray to light gray. Laminations locally alternate from near black to light gray.

Carbonate-clast conglomerate beds range from 2 ft to as much as 50 ft thick, and most are laterally discontinuous. The deposits generally are poorly sorted and can be either clast or matrix supported. On the hillsides above Eagle Creek between East Eagle Creek and Basin Creek are several resistant limestone knobs composed of laterally discontinuous sequences of massive and thick-bedded carbonate turbidite and limestone conglomerate. They are surrounded by less resistant shale and thin limestone interbeds. Follo (1986) suggested that these bodies represent submarine channel-fill deposits.

Following are brief descriptions of several limestones in the Eagle Creek area.

Paddy Creek deposit (locality C-1):

Location: NW¼SW¼ sec. 15, T. 7 S., R. 44 E., in a road cut along the west side of Paddy Creek. Sparta 15-minute quadrangle.

Owner: USFS land. No development.

The limestone is exposed over a length of about 500 ft. It extends as much as 50 ft above the road. Above that, the slope is covered with thick overburden. The limestone is bedded. Beds range from 2 in. to 3 ft thick. Bedded limestone-clast conglomerate occurs in the central part of the exposure. Bedding strikes N. 80° W. and dips 55° S. The limestone is dark gray with some thin calcite veins. Weathered surfaces are lighter gray. Samples AUB-64 through -68 (Table 1) were taken from north to south. Each represents about 100 ft of the exposure.

Locality 278 (locality C-2):

Location: SW¼ sec. 15, T. 7 S., R. 44 E., on the east side of Paddy Creek. Sparta 15-minute quadrangle.

Owner: USFS land. No development.

The top of the exposure is about 100 yd west of a road at about the 4,540-ft elevation. The outcrop, which is about 100 ft across the top, parallels the slope and extends downslope less than 300 ft. The slope is steep and timbered. The limestone is surrounded by calcareous and noncalcareous shales. The deposit is massive to thin bedded and includes some carbonate-clast conglomerate. Analysis of a grab sample (AUB-70) is given in Table 1.

Martin's Bridge (locality C-3):

Location: North-central part of sec. 21, T. 7 S., R. 44 E., at the mouth of Paddy Creek. Sparta 15-minute quadrangle.

Owner: USFS land. No development.

This is the type locality of the Martin Bridge Limestone, named for a bridge that no longer exists across Eagle Creek.

The deposit consists of interbedded black carbonaceous shale and dark-gray limestone. Table 7 illustrates a section along the top of the sharp ridge (samples AUB-78 through -90) separating the lower half mile of Paddy Creek on the east from Eagle Creek on the west. The section extends northward from Eagle Creek at about the 3,300-ft elevation to the south edge of a basalt capping at about the 5,850-ft elevation. The strike of the bedding varies from N. 5° W. to N. 15° E., and dips vary from 5° to 25° E. Ross (1938) described a 630-ft section at this locality.

Table 7. *Description of a section of the Martin Bridge Limestone at the mouth of Paddy Creek (locality C-3), southern Wallowas area, beginning at the confluence of Paddy Creek with Eagle Creek. The sample line is oriented to the north.*

Interval (ft)	Elevation (ft)	Sample no.	Description
0-100	3,370	AUB-78	Interbedded black carbonaceous shale. Beds range from under 1 in. to 6 ft. Limestone thinly laminated to massive. Alternating light and dark laminae give rock a striped appearance.
100-180	--	AUB-79	
180-220	--	AUB-80	
220-224[1]	--	AUB-81	
220-320	--	AUB-82	
320-420	--	AUB-83	
420-520	--	AUB-84	
520-620	--	AUB-85	
620-888	--	No sample	Soil-covered zone.
888-1,050	--	No sample	Sandstone and siltstone.
1,050-1,250	3,750	AUB-86	Limestone bed about 35 ft thick dips 25° NE.
1,250-1,690	--	No sample	Mostly noncarbonate clastic rocks.
1,690-1,790	3,840	AUB-87	Limestone dips 15° NE.
1,790-1,990	--	No sample	Limestone similar to interval 1,690-1,790 ft.
1,990-2,090	--	No sample	Clastic rock.
2,090-2,190	--	AUB-88	Limestone interval 60 ft thick; lower 35 ft is conglomeratic.
2,190-2,290	--	AUB-89	
2,290-2,390	3,940	AUB-90	

[1]Sample represents a 4-ft interval of black carbonaceous shale.

Larkspur Creek (locality C-4):

Location: Near the line between secs. 15 and 16, T. 7 S., R. 43 E. Sparta 15-minute quadrangle.

Owner: USFS land. No development.

Limestone float and small exposures occur in the bank of the Larkspur Creek road over a distance of about 400 ft. Some limestone-clast conglomerate is included. Exposure is too poor to permit visual determination of other dimensions of the deposit. Chemical analysis of a sample of random chips (AUB-60) from small outcrops is given in Table 1.

Larkspur Creek 2 (locality C-5):

Location: SE¼SE¼ sec. 15, T. 7 S., R. 43 E., on the southeast side of Larkspur Creek about 0.2 mi from its junction with Goose Creek. Sparta 15-minute quadrangle.

Owner: USFS land. No evidence of development.

The outcrop is about 350 ft long parallel to the creek and extends up the steep hillside about 250 ft in elevation above the creek. The limestone is dark gray on fresh surfaces and contains small calcite veinlets and minor quartz and iron oxide. Analyses of three 100-ft composite chip samples (AUB-61 through -63) are given in Table 1. The samples were taken from south to north across the lower part of the outcrop.

Snake River canyon area (area D)

This area includes the limestone deposits on the Oregon side of the Snake River canyon north of Oxbow Dam. The Martin Bridge Limestone is well exposed near Big Bar, and smaller deposits occur in the older volcanic rocks of the Seven Devils Group. Some of the best exposures are in the Wild Sheep Creek Formation along Bull, Hat, Cherry, and Jim Creeks, where argillaceous limestone occurs in units as much as 300 ft thick (Vallier, 1977). There has been no development.

Big Bar limestone (locality D-1):

Location: Large exposures of the Martin Bridge Limestone occur on both sides of the Snake River near the former site of Big Bar, which was largely inundated by Hells Canyon Reservoir. The deposits in Oregon are in (projected) secs. 7, 8, 17, 18, 19, and 20, T. 5 S., R. 49 E., and secs. 13, 23, 24, and 26, T. 5 S., R. 48 E. Homestead and Cuprum 15-minute quadrangles.

Owner: USFS land. Hells Canyon Wilderness.

The limestone is well exposed in Spring Creek, Leep Creek, and Kirby Creek. Exposures are better and more accessible across the river in Idaho, where the limestone is cut by the Idaho Power Company highway that follows the Idaho bank of the river from Oxbow to Hells Canyon Dam.

The limestone overlies the Wild Sheep Creek Formation of the Seven Devils Group and is locally overlain by basalt flows and associated rocks of the Tertiary Columbia River Basalt Group. About 1,750 ft of limestone section are exposed in Kinney Creek in Idaho. The top of the limestone is not exposed, and the total thickness is not known.

The limestone is gray to near black on fresh surfaces and weathers to a light gray. Beds range in thickness from a few inches to 75 ft or more but average 5 ft or less. Laminated beds are common. Limestone breccia is included locally. Most of the limestone is recrystallized and nonfossiliferous, but thin beds containing an abundance of silicified fossils occur at several horizons.

Analyses of three samples of the limestone are given in Table 1 (samples AVB-113 through -115). The samples are from the northern, middle, and southern parts of the exposure near the level of the Snake River. Chemical, X-ray diffraction, and thin-section analyses indicate that dolomitic limestone and dolomite are present locally. Carbonaceous material is common and locally abundant enough that some of the limestone is nearly black. Some of the limestone is also clay-rich. Chert bands are visible locally. The content of insoluble residue, mainly clay and carbon, of 24 samples analysed by Vallier (1977) ranged from 1 to 21 percent by weight. The average of 20 of those samples was 4.94 percent.

Twin Lakes (locality D-2):

Location: Secs. 2, 3, and 11, T. 6 S., R. 46 E., near Twin Lakes in the southeastern part of the Wallowa Mountains. Cornucopia 15-minute quadrangle.

Owner: USFS land.

Vallier (1967) reported that limestone occurs as isolated pods and lenses up to 300 ft long and 120 ft wide in the Wild Sheep Formation. He mentioned an occurrence at the 6,780-ft elevation on the Fish Lake-Twin Lakes road in NE¼SW¼SW¼ sec. 2, T. 6 S., R. 46 E.; another at the 6,580-ft elevation along the north side of Big Elk Creek in the NE¼NW¼ sec. 11, T. 6 S., R. 46 E.; and another between the 6,800- and 6,900-ft elevations along the eastern edge of sec. 3, T. 6 S., R. 46 E. The limestone is described as dark gray and fine grained. Beds range from 1 to 8 in. in thickness. Evans (1986) reported that a Jurassic or younger diorite and gabbro pluton contains xenoliths of the limestone.

Cherry Creek (locality D-3):

Location: T. 5 N., R. 47 E., and T. 5 N., R. 48 E. Jim Creek Butte, Wapshilla Creek, and Poison Point 7½-minute quadrangles. The deposits are in the Grand Canyon of the Snake River and not accessible by road. There has been no development. Much of the following information is from Goldstrand (1987).

As described by Goldstrand (in preparation), the limestone deposits are in the upper part of the Wild Sheep Creek Formation and are interbedded with mafic pillow lavas and breccias, tuffs, and volcaniclastic sedimentary rocks. Carbonate rocks crop out on both sides of the Snake River. Two thick, cliff-forming, limestone marker units crop out on the Oregon side from Cherry Creek to north of Coon Creek. The lower unit is between 130 and 423 ft thick. It is thickest in the Coon Creek area and thins to the north and south. The upper unit is between 160 and 360 ft thick and thickens to the north. The upper portions of both units are rich in volcaniclastic debris, dominantly scoriaceous lapilli.

Keating-Medical Springs area (area E)

This area includes the pioneer ranching communities of Keating and Medical Springs and is centered about 20 mi northeast of Baker on the north side of the Powder River.

The limestone deposits occur as small pods and lenses intercalated with weakly metamorphosed (greenschist facies) lavas, tuffs, and related rocks of the Clover Creek Greenstone of Permian and Upper Triassic age.

The limestone deposits comprise a small fraction of 1 percent of the formation but are widely distributed. Most of them are small, ranging from a few feet to several hundred feet long and a few inches to several tens of feet thick. The largest bodies are northwest of Table Mountain in T. 7 S., R. 42 E., where an exposure in the NE¼ sec. 18 is about 1,300 ft long and 200 ft wide. The limestone typically is gray to dark gray on fresh surfaces and weathers light gray.

Although some of the deposits contain good-quality limestone, none appear to have commercial value because of their limited size and remote location. Some could be used as local sources of agricultural limestone.

Sec. 34 deposits (locality E-1):

Location: SW¼NE¼ and NW¼SE¼ sec. 34, T. 7 S., R. 42 E., 3,300-ft elevation. Sawtooth Ridge 7½-minute quadrangle.

Owner: Not determined.

Distribution of small outcrops and float indicate that at least three small disconnected bodies of blue-gray limestone are present in an area 1,400 ft long and 300 ft thick. The southern exposure is the largest. It is about 300 ft long and 80 ft thick. The northern exposure contains two small excavations from which several tons of limestone evidently were removed many years ago. The limestone is massive, gray to dark gray, and largely recrystallized.

Analysis of one sample (AVB-97) from the northern exposure is given in Table 1.

Sec. 23 deposits (locality E-2):

Location: NE¼NE¼ sec. 23, T. 7 S., R. 41 E., adjacent to Oregon Highway 203. Keating NW 7½-minute quadrangle.

Dark-gray limestone layers a few inches to a foot or two thick are interbedded with volcaniclastic rocks including sandstone and siltstone. Locally, the limestone is sandy; in other places, it contains diagenetic chert seams and layers. Due to its obvious poor quality and poor exposure, the full extent of the limestone-bearing area was not determined. It appears to be about 300 ft wide west of the highway.

Analysis of a grab sample (AVB-98) of the limestone is presented in Table 1.

Baker terrane deposits

In Oregon, exposures of the Baker terrane form a broad belt extending westerly from the Snake River across Baker County and most of Grant County. The terrane comprises a tectonic mix of rocks from pre-existing island-arc, oceanic-crust, seamount, and associated sedimentary packages ranging from Devonian to Late Triassic in age. Included are large and small blocks of argillite and chert, serpentinite, ultramafic rock, gabbro, plagiogranite, and greenstone, as well as melanges in which fragments of gabbro, diorite, greenstone, chert and argillite, and amphibolite are chaotically arrayed in a matrix of serpentinite. The more chaotically mixed rocks are in the western part of the terrane.

The important limestone deposits are in the eastern part of the terrane and are associated with the Nelson Marble, Burnt River Schist, and Elkhorn Ridge Argillite. Each of these units forms an east- to northeast-trending belt that approximately parallels the trend of the Baker terrane.

Small limestone deposits associated with rocks equivalent to the Elkhorn Ridge Argillite occur in the John Day and Antone areas in the western part of the terrane.

The Elkhorn Ridge Argillite is by far the most widely exposed sedimentary unit in the Baker terrane. It is composed mainly of argillite and chert, with small amounts of tuff, tuffaceous argillite, conglomerate, lava flows, sandstone, and limestone lenses. The Burnt River Schist and Nelson Marble are in the southeastern part of the Baker terrane. The former is composed mainly of siliceous phyllite, metachert, greenschist, and greenstone. The Nelson Marble consists of crystalline limestone and dolomitic limestone interlayered with phyllitic rocks. Rocks of the two units are folded together, but whether the Nelson Marble is stratigraphically a part of the Burnt River Schist or a younger unit is not clear.

Limestone-bearing areas in the Baker terrane discussed below are the Durkee-Fox Creek, Bald Mountain, Pleasant Valley-Virtue Hills, Elkhorn Ridge, John Day, and Dayville-Antone areas.

Durkee-Fox Creek area (area F)

This area includes the Nelson Marble and correlative carbonate deposits associated with the Burnt River Schist. The area also includes some small travertine deposits of recent age, one of which is described elsewhere in this report in the section entitled "Isolated deposits and lacustrine limestone and travertine deposits in eastern Oregon."

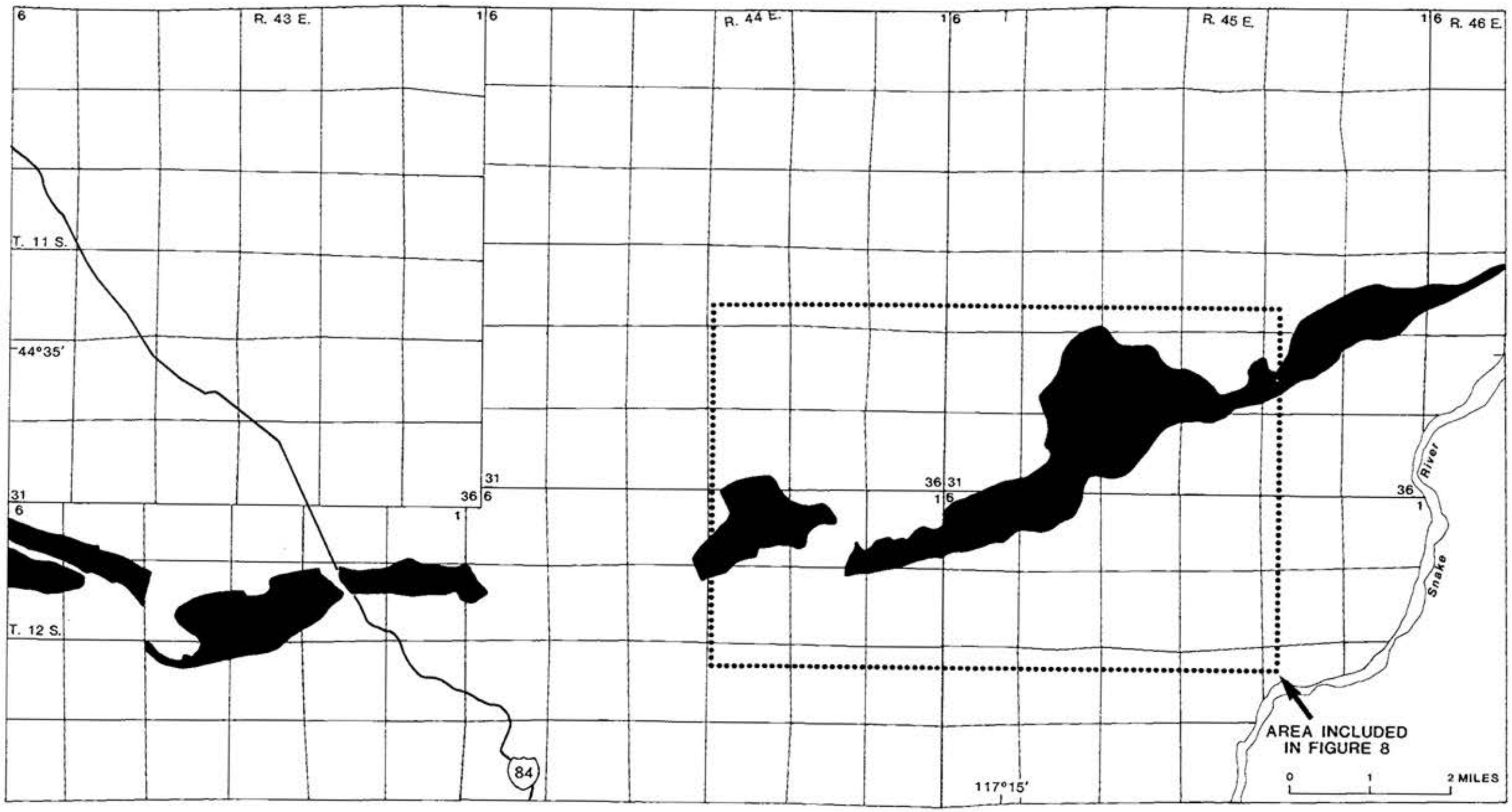

Figure 7. Map of the Durkee-Fox Creek area (area F), showing distribution of the Nelson Marble (solid areas). Area covered by Figure 8 is indicated. Adapted from Prostka (1967) and Brooks (1979b).

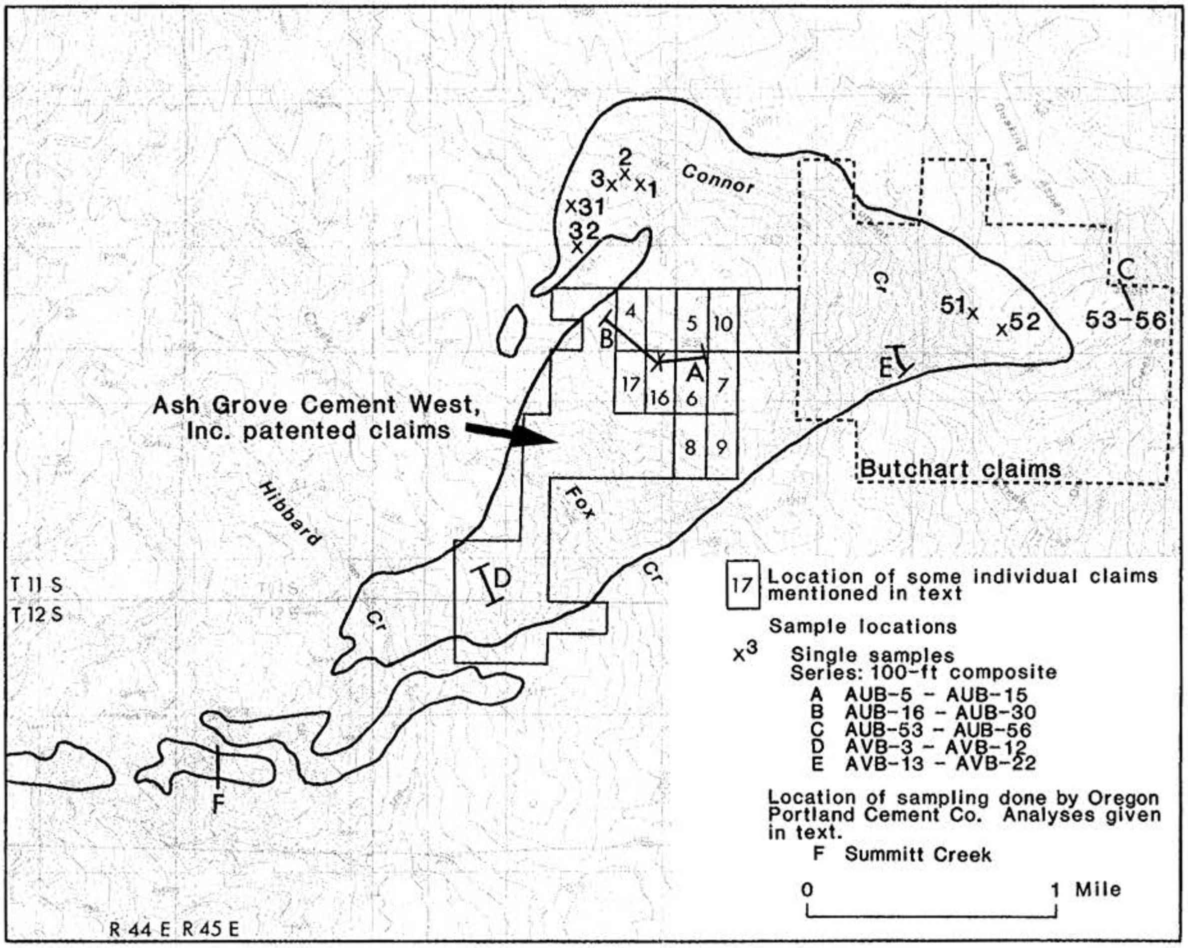

Figure 8. Map showing distribution of the Nelson Marble, claims, and sample sites in the upper Fox Creek area.

Exposures of the Nelson Marble in Oregon form a belt about 30 mi long, extending east and northeast from the western part of Burnt River canyon southwest of Durkee to the Snake River near the mouth of Soda Creek (Figure 7). The belt continues across the Snake River into Idaho for several miles. The unit was named by Prostka (1967) for the exposure at Nelson near the Durkee quarry. The western part of the belt is crossed by Interstate I-84 and the Union Pacific Railroad.

More than 15.6 million tons of carbonate rock have been produced from the Nelson Marble through 1986, nearly all of it from the Durkee quarry now owned and operated by Ash Grove Cement West, Inc. About 65 percent of this production was used in cement manufacture.

Brief descriptions and maps of various parts of the Nelson Marble unit are provided by Gilluly (1937), Moore (1937), Prostka (1967), Ashley (1966, and in preparation), Brooks and others (1976), and Brooks (1979b). Most of the following information is from those references.

In the western part of the belt, particularly in Burnt River canyon, limestone of the Nelson Marble occurs as tectonically scattered lenses and pods a few tens of feet to several thousand feet in longest dimension separated by extensive thicknesses of phyllitic rocks. In the central and eastern parts of the exposure belt, the marble exposures are larger and more continuous. Thicknesses range from about 700 ft on the bank of the Snake River to nearly a mile in the upper Fox Creek area on the divide between Burnt River and the Snake River. The latter thickness is probably not a true stratigraphic thickness and may be due to tectonism.

Regional strike of the unit swings from nearly due east in the western part to about N. 65° E. in the eastern part. Bedding and cleavage in the limestone and intervening clastic rocks approximately parallel these trends and dip steeply north or, rarely, south.

The Durkee-Fox Creek area in Tps. 11 and 12 S., Rs. 44 and 45 E., (Figure 8) contains the largest reserves of good-quality, uniform-grade limestone (Figure 9) in Oregon outside of the wilderness area of the Wallowa Mountains. Although reserves appear to be enormous, the limestone has not been developed because of its relative inaccessibilty and distance from major sources of transportation. Best access to the area is via Interstate I-84 southeast from Baker, thence northeast via the Lookout Mountain road (gravel and dirt, well-traveled) to the head of Fox Creek. From there, large exposures of blue-gray limestone are visible to the east. Four-

Figure 9. Nelson Marble, Durkee-Fox Creek area (area F).

wheel-drive roads a mile or two long provide access to exposures on the ridge crests between Hibbard and Fox Creeks and Fox and Connor Creeks. Four-wheel-drive roads up Hibbard and Connor Creeks from the Snake River road provide access to other parts of the area.

The limestone masses dip steeply northwest and form cockscomb ridges, bold outcrops, and steep slopes that commonly are nearly barren of soil. In some areas, limestone ribs tens of feet to many hundreds of feet thick are separated by zones of slate and phyllite of similar thicknesses that are more subdued topographically and are mantled by soil and limestone debris. In the upper Fox Creek and Hibbard Creek areas, the northern margin of the limestone is marked by Late Jurassic quartz diorite. The limestone adjacent to the intrusive has been altered and recrystallized, but skarn-type minerals are surprisingly rare. Zones a few feet thick of altered rock containing epidote, tremolite(?), and pyrite were observed along the contact in a few places, notably in the south-central part of sec. 29, T. 11 S., R. 45 E., at about the 6,200-ft elevation.

The limestone ranges from dark shades of gray to nearly white and from finely to very coarsely crystalline. No original textures or megafossils are preserved. Some of the rock is banded. Pale-gray to white limestone that may be useful for whiting and filler materials occurs locally but probably not in large quantity. One of the largest exposures is in the NE¼ sec. 29, T. 11 S., R. 45 E., and is further discussed in the section entitled "Upper Connor Creek (locality F-3)." The whiter limestone occurrences are near the intrusive contact. Some are riddled with dikes that would make mining difficult. The nearly white limestone bodies in the south-central part of sec. 29 are clearly small roof pendants no more than a few tens of feet thick.

On Hibbard Creek in secs. 5 and 6, T. 12 S., R. 45 E., gray limestone is intercalated with phyllite, and both are locally cut by granitic dikes.

In Burnt River canyon, the limestone occurrences form numerous irregularly shaped, massive, light-gray or bluish-gray outcrops separated by generally light-colored phyllitic rocks derived from sedimentary or volcaniclastic rocks. The sequence has been highly contorted by folding and small-scale faulting.

The limestone bodies are aligned in belts that trend approximately parallel to foliation of the phyllite. Some of the bodies reflect structural disruption and dispersal of once-continuous beds, and some were deposited as lenses. The exposures of marble in the walls of Burnt River canyon just west of the French Gulch/Burnt River confluence reveal a westward-plunging antiform that probably repeats two limestone-bearing horizons (Ashley, in preparation).

Following are descriptions of certain parts of the Nelson Marble where development has occurred or for which sample analyses are available.

Ash Grove property (locality F-1):

Location: Secs. 28, 29, 32, and 33, T. 11 S., R. 45 E., and sec. 5, T. 12 S., R. 45 E., mostly in the Fox Creek drainage but extending northeast and southwest into the Connor Creek and Hibbard Creek drainages, respectively. Mineral and Durkee 15-minute quadrangles.

Owner: The property consisting of 526 acres of patented mining claims is owned by Ash Grove Cement West, Inc., and is centered about 10 air mi northeast of its cement plant at Durkee.

A large amount of hand sampling was done in 1949 and 1960-1961. Two short adits and some shallow cuts were excavated as part of that work, but the property is otherwise undeveloped. A few truckloads of limestone were removed from a cut on the southwest side near the top of the ridge between Hibbard Creek and Fox Creek in the SW¼SW¼ sec. 32, T. 11 S., R. 45 E.

Carbonate rock underlies most of the area within the claim block and is exposed through about 2,400 ft of relief in the Fox Creek drainage.

Analyses of samples from claims 6 and 8 are presented in Table 8. The samples were taken at 25-ft intervals along east-west lines spaced 200 ft apart, starting at the north edge of claim 6 and ending at the south edge of claim 8. Sample numbers increase from west to east.

Table 8. *Chemical analyses of limestone samples taken at approximately 25-ft intervals from claims 6 and 8 on the Ash Grove property (locality F-1) in the Durkee-Fox Creek area. Sampling and analyses by Oregon Portland Cement Company in 1960-1961, M.J. O'Dell, analyst. Sample numbers increase from west to east.*

Claim no.	Line	Sample no.	$CaCO_3$	$MgCO_3$
6	A	0	98.24	0.96
6	A	1	98.98	0.52
6	A	2	97.71	0.98
6	A	3	98.75	0.67
6	A	4	98.60	0.88
6	A	5	98.80	0.56
6	A	6	93.60	2.90
6	A	7	85.10	11.79
6	A	8	98.44	0.92
6	A	9	98.62	0.65
6	A	10	98.98	0.79
6	A	11	98.80	0.88
6	A	12	98.62	0.73
6	A	13	95.14	4.77
6	A	14	89.86	9.95
6	A	15	98.33	0.64
6	A	16	97.51	1.34
6	A	17	95.47	4.08
6	A	18	84.92	14.90
6	A	19	98.44	1.09
6	A	20	98.80	0.38
6	A	21	94.41	5.75
6	A	22	84.25	15.72
6	A	23	98.44	1.15
6	A	24	98.69	0.98
6	A	25	98.75	0.96
6	A	26	98.05	1.52
6	A	27	98.45	1.00
6	A	28	97.15	2.01
6	A	29	96.97	2.88
6	A	30	98.80	0.71
6	A	31	86.93	12.96
6	A	32	88.68	11.08
6	A	33	98.80	0.60

Claim no.	Line	Sample no.	$CaCO_3$	$MgCO_3$
6	C	0	98.44	0.75
6	C	1	98.80	0.52
6	C	2	98.80	0.75
6	C	3	98.95	0.45
6	C	4	98.85	0.64
6	C	5	98.95	0.58
6	C	6	98.80	0.69
6	C	7	98.50	0.94
6	C	8	97.71	1.65
6	C	9	98.71	1.00
6	C	10	98.62	0.96
6	C	11	98.08	1.55
6	C	12	98.80	0.67
6	C	13	98.49	1.07
6	C	14	97.97	1.67
6	C	15	98.31	0.79
6	C	16	98.49	0.38
6	C	17	98.33	1.32
6	C	18	98.87	0.84
6	C	19	98.91	0.42
6	C	20	98.95	0.54
6	C	21	98.85	0.69
6	C	22	95.99	1.92
6	C	23	97.24	1.57
6	C	24	96.61	1.71
6	C	25	98.13	1.96
6	C	26	98.40	1.00
6	C	27	98.58	0.97
6	C	28	98.67	1.03
6	C	29	98.13	1.25
6	C	30	98.13	0.90
6	C	31	96.64	1.90
6	C	32	97.35	2.38
6	C	33	98.13	1.21
6	E	0	98.67	0.65
6	E	1	98.13	0.79
6	E	2	98.13	0.70
6	E	3	98.31	1.34
6	E	4	98.14	1.23
6	E	5	98.58	0.63
6	E	6	99.19	0.54
6	E	7	98.86	0.65
6	E	8	99.14	0.52
6	E	9	98.86	0.48
6	E	10	98.86	0.44
6	E	11	98.76	0.94
6	E	12	99.28	0.52
6	E	13	99.28	0.38
6	E	14	98.76	1.14
6	E	15	95.03	4.10
6	E	16	97.33	1.05
6	E	17	94.52	4.93
6	E	18	99.19	0.65
6	E	19	99.03	0.65
6	E	20	97.80	1.78
6	E	21	90.59	8.10
6	E	22	98.22	0.92
6	E	23	98.40	0.46
6	E	24	98.22	0.54
6	E	25	98.83	0.44
6	E	26	96.84	2.03
6	E	27	99.01	0.25
6	E	28	99.01	0.77
6	E	29	94.03	5.56
6	E	30	95.77	4.91
6	E	31	98.47	1.13
6	E	32	99.01	0.90
6	E	33	92.28	5.98
6	E	34	96.88	3.26
6	G	0	98.65	1.00
6	G	1	95.46	3.87
6	G	2	99.01	0.84
6	G	3	99.05	0.89
6	G	4	98.65	0.50
6	G	5	98.47	0.65
6	G	6	98.29	0.79
6	G	7	96.17	0.96
6	G	8	98.65	0.96
6	G	9	98.11	0.90
6	G	10	98.74	0.69
6	G	11	98.29	0.96
6	G	12	98.74	0.79
6	G	13	98.56	1.19
6	G	14	98.65	1.07
6	G	15	98.47	1.11
6	G	16	98.02	0.98
6	G	17	98.83	0.90
6	G	18	98.74	0.69
6	G	19	98.65	0.92
6	G	20	97.76	1.15
6	G	21	98.74	1.05
6	G	22	97.76	1.15
6	G	23	97.04	2.92
6	G	24	94.39	5.30
6	G	25	98.83	0.78

Claim no.	Line	Sample no.	$CaCO_3$	$MgCO_3$
6	G	26	95.28	3.69
6	G	27	98.99	0.62
6	G	28	98.55	1.34
6	G	29	99.01	0.89
6	G	30	96.35	3.47
6	G	31	96.71	1.38
6	G	32	93.36	6.75
6	G	33	96.53	1.34
6	G	34	84.99	6.10
6	I	0	99.01	1.02
6	I	1	99.09	0.79
6	I	2	98.76	1.02
6	I	3	98.65	1.11
6	I	4	96.55	1.96
6	I	5	97.05	2.04
6	I	6	98.67	0.80
6	I	7	98.63	0.85
6	I	8	97.55	1.90
6	I	9	98.83	0.92
6	I	10	98.01	1.71
6	I	11	98.81	1.07
6	I	12	98.99	0.85
6	I	13	99.01	0.88
6	I	14	98.82	1.00
6	I	15	98.92	0.98
6	I	16	98.92	0.92
6	I	17	94.83	1.63
6	I	18	98.47	0.90
6	I	19	99.19	0.79
6	I	20	85.33	13.25
6	I	21	98.50	1.36
6	I	22	98.83	0.86
6	I	23	98.47	1.02
6	I	24	97.24	2.26
6	I	25	97.78	1.09
6	I	26	98.67	0.65
6	I	27	98.95	0.51
6	I	28	94.42	5.20
6	I	29	98.47	0.73
6	I	30	97.96	1.55
6	I	31	99.01	0.82
6	I	32	97.06	1.76
6	I	33	98.28	1.55
6	K	0	97.22	0.98
6	K	1	98.47	1.13
6	K	2	90.32	9.29
6	K	3	98.65	0.96
6	K	4	89.79	9.97
6	K	5	98.29	1.71
6	K	6	89.52	10.22
6	K	7	96.97	2.49
6	K	8	98.65	0.88
6	K	9	97.76	1.86
6	K	10	96.86	2.02
6	K	11	70.60	28.45
6	K	12	83.40	16.13
6	K	13	98.47	0.73
6	K	14	89.61	10.38
6	K	15	89.25	10.51
6	K	16	92.62	6.04
6	K	17	95.81	3.37
6	K	18	99.19	0.56
6	K	19	96.17	3.23
6	K	20	92.73	8.03
6	K	21	92.11	8.15
6	K	22	93.67	6.07
6	K	23	97.33	2.27
6	K	24	89.90	9.40
6	K	25	81.77	17.46
6	K	26	97.78	0.98
6	K	27	98.31	1.30
6	K	28	97.78	1.61
6	K	29	96.71	1.11
6	K	30	97.97	0.95
6	K	31	97.24	1.21
6	K	32	97.24	1.36
6	K	33	94.03	4.08
6	K	34	95.10	3.97
6	M	0	92.34	5.90
6	M	1	95.19	4.45
6	M	2	91.46	7.99
6	M	3	98.32	0.94
6	M	4	98.94	0.75
6	M	5	88.98	10.66
6	M	6	91.93	7.57
6	M	7	98.57	1.30
6	M	8	97.60	2.27
6	M	9	98.33	1.34
6	M	10	98.87	1.03
6	M	11	95.66	3.27
6	M	12	86.56	11.42
6	M	13	90.68	3.62
6	M	14	97.62	1.88
6	M	15	90.86	2.72
6	M	16	83.54	12.23

Claim no.	Line	Sample no.	$CaCO_3$	$MgCO_3$
6	M	17	96.90	1.42
6	M	18	95.66	1.09
6	M	19	98.15	0.82
6	M	20	97.04	1.31
6	M	21	98.53	0.79
6	M	22	97.42	1.39
6	M	23	91.55	8.29
6	M	24	99.20	0.46
6	M	25	97.60	1.59
6	M	26	97.42	0.88
6	M	27	97.60	1.04
6	M	28	96.32	2.09
6	M	29	99.07	0.92
6	M	30	98.15	1.46
6	M	31	97.76	1.19
6	M	32	98.69	0.82
6	M	33	98.15	1.01
6	M	34	98.30	0.92
8	A	0	96.87	2.63
8	A	1	97.40	2.40
8	A	2	90.14	7.86
8	A	3	96.50	2.36
8	A	4	88.84	10.09
8	A	5	91.84	7.71
8	A	6	97.22	2.23
8	A	7	91.37	8.36
8	A	8	97.95	0.96
8	A	9	84.79	12.48
8	A	10	91.02	6.52
8	A	11	97.60	1.17
8	A	12	98.87	0.46
8	A	13	97.60	1.61
8	A	14	98.89	0.88
8	A	15	99.07	0.69
8	A	16	95.08	3.49
8	A	17	98.89	0.48
8	A	18	98.15	1.69
8	A	19	97.22	1.82
8	A	20	97.60	1.30
8	A	21	98.15	1.20
8	A	22	80.52	7.98
8	A	23	96.68	2.98
8	A	24	97.42	2.31
8	A	25	90.82	8.11
8	A	26	86.59	12.65
8	A	27	91.55	8.08
8	A	28	95.30	3.14
8	A	29	96.87	3.30
8	A	30	98.15	1.17
8	A	31	93.49	6.04
8	A	32	96.59	1.91
8	A	33	98.80	0.98
8	A	34	96.21	3.05
8	C	0	96.87	2.76
8	C	1	98.15	1.69
8	C	2	90.64	8.84
8	C	3	97.80	1.96
8	C	4	95.68	3.85
8	C	5	97.33	0.94
8	C	6	96.57	3.05
8	C	7	98.90	0.56
8	C	8	93.87	5.65
8	C	9	98.80	0.52
8	C	10	96.59	2.03
8	C	11	97.33	1.05
8	C	12	89.09	10.56
8	C	13	98.98	0.75
8	C	14	98.80	0.85
8	C	15	95.85	3.66
8	C	16	89.11	10.57
8	C	17	94.39	3.99
8	C	18	94.21	4.18
8	C	19	87.43	12.33
8	C	20	88.54	10.95
8	C	21	87.60	12.05
8	C	22	98.19	0.85
8	C	23	98.80	0.56
8	C	24	92.22	6.83
8	C	25	97.33	2.30
8	C	26	98.62	1.27
8	C	27	81.73	17.40
8	C	28	85.41	13.60
8	C	29	97.49	1.86
8	C	30	99.23	0.47
8	C	31	97.51	1.80
8	C	32	97.51	1.31
8	C	33	97.69	1.70
8	C	34	98.80	0.91
8	E	0	74.21	23.50
8	E	1	97.51	1.19
8	E	2	98.80	0.90
8	E	3	95.57	2.17
8	E	4	96.41	2.03
8	E	5	95.66	3.62
8	E	6	94.01	5.82
8	E	7	94.56	1.42
8	E	8	83.58	15.28
8	E	9	98.71	0.94
8	E	10	96.41	3.13
8	E	11	96.21	3.25
8	E	12	92.95	5.83
8	E	13	96.21	3.30
8	E	14	81.36	16.51
8	E	15	91.66	6.17
8	E	16	90.93	6.54
8	E	17	84.68	14.07
8	E	18	86.52	11.75
8	E	19	99.18	0.79
8	E	20	99.00	0.90
8	E	21	98.24	1.33
8	E	22	93.92	5.33
8	E	23	98.62	1.19
8	E	24	91.11	8.09
8	E	25	97.97	1.65
8	E	26	98.42	0.84
8	E	27	94.39	3.74
8	E	28	87.61	11.52
8	E	29	98.99	0.92
8	E	30	98.42	1.48
8	E	31	97.69	2.19
8	E	32	98.24	1.63
8	E	33	96.03	3.71
8	G	0	78.19	21.11
8	G	1	98.42	1.09
8	G	2	96.32	3.40
8	G	3	98.15	1.25
8	G	4	97.89	1.63
8	G	5	92.22	7.63
8	G	6	94.01	5.75
8	G	7	97.69	2.21
8	G	8	98.62	0.77
8	G	9	96.41	1.96
8	G	10	97.13	1.80
8	G	11	97.42	1.82
8	G	12	98.06	1.10
8	G	13	98.42	1.15
8	G	14	98.42	1.25
8	G	15	98.78	0.98
8	G	16	98.78	1.14
8	G	17	98.52	1.17
8	G	18	98.78	1.04
8	G	19	98.78	0.78
8	G	20	98.98	0.98
8	G	21	98.80	0.61
8	G	22	99.09	0.56
8	G	23	98.42	1.26
8	G	24	97.35	1.92
8	G	25	98.73	0.97
8	G	26	83.02	13.98
8	G	27	92.22	4.05
8	G	28	99.09	0.70
8	G	29	94.41	1.12
8	G	30	98.06	1.38
8	G	31	98.98	0.84
8	G	32	97.51	1.52
8	G	33	92.75	4.05
8	I	0	95.90	3.20
8	I	1	97.33	1.74
8	I	2	96.97	1.25
8	I	3	97.69	1.48
8	I	4	97.51	1.73
8	I	5	98.40	0.63
8	I	6	96.30	1.78
8	I	7	98.78	0.85
8	I	8	98.64	1.17
8	I	9	99.18	0.69
8	I	10	98.80	0.85
8	I	11	99.00	0.76
8	I	12	85.57	12.42
8	I	13	98.82	1.05
8	I	14	98.75	1.05
8	I	15	99.00	0.75
8	I	16	98.78	1.05
8	I	17	98.20	1.72
8	I	18	98.16	1.73
8	I	19	96.12	3.74
8	I	20	96.82	2.84
8	I	21	98.44	1.21
8	I	22	85.72	14.11
8	I	23	98.08	1.25
8	I	24	98.73	0.96
8	I	25	95.10	1.11
8	I	26	98.55	0.96
8	I	27	95.99	3.61
8	I	28	91.13	2.09
8	I	29	98.17	1.50
8	I	30	97.63	1.78
8	I	31	99.09	0.71

Claim no.	Line	Sample no.	$CaCO_3$	$MgCO_3$
8	I	32	97.99	1.44
8	I	33	97.08	2.72
8	I	34	98.73	1.17
8	K	0	90.21	9.84
8	K	1	93.18	0.84
8	K	2	98.91	0.63
8	K	3	99.01	0.38
8	K	4	98.91	0.61
8	K	5	95.10	3.53
8	K	6	98.37	0.86
8	K	7	98.55	0.69
8	K	8	98.73	1.17
8	K	9	98.91	1.06
8	K	10	96.37	1.13
8	K	11	98.91	0.75
8	K	12	99.09	0.73
8	K	13	98.17	1.52
8	K	14	98.35	1.25
8	K	15	99.09	0.82
8	K	16	98.73	1.07
8	K	17	98.91	0.29
8	K	18	99.09	0.75
8	K	19	97.91	1.00
8	K	20	97.73	1.45
8	K	21	98.98	0.79
8	K	22	99.10	0.68
8	K	23	98.72	0.86
8	K	24	98.10	1.33
8	K	25	99.36	0.42
8	K	26	98.82	1.02
8	K	27	98.56	1.11
8	K	28	97.55	1.69
8	K	29	96.82	2.28
8	K	30	99.00	0.65
8	K	31	98.64	0.92
8	K	32	93.74	4.03
8	M	0	97.35	0.98
8	M	1	99.00	0.82
8	M	2	99.18	0.63
8	M	3	99.09	0.67
8	M	4	98.46	1.25
8	M	5	98.64	0.88
8	M	6	98.55	0.84
8	M	7	98.37	0.92
8	M	8	98.91	0.77
8	M	9	98.55	0.85
8	M	10	99.18	0.44
8	M	11	98.91	0.63
8	M	12	99.00	0.90
8	M	13	98.35	0.61
8	M	14	98.35	1.19
8	M	15	97.46	1.90
8	M	16	98.73	0.86
8	M	17	98.55	1.07
8	M	18	99.09	0.67
8	M	19	98.46	0.52
8	M	20	98.46	1.50
8	M	21	99.00	1.40
8	M	22	92.95	6.65
8	M	23	86.97	12.67
8	M	24	99.09	0.67
8	M	25	99.27	0.79
8	M	26	98.35	1.57
8	M	27	94.92	4.97
8	M	28	97.82	2.03
8	M	29	98.17	1.48
8	M	30	95.28	3.86
8	M	31	98.17	1.40
8	M	32	98.58	1.07

It appears that hundreds of millions of tons of good-quality limestone are available, although results of surface sampling indicate that the dolomite content is high locally. Therefore, in some areas, careful sampling and selective mining would be required. One of the largest dolomitic zones is in the northern part of claims 16 and 17, where limestone and dolomitic limestone are mixed. A few samples were pure dolomite.

A 167-ft-long tunnel in the northeast corner of claim 6 crosscuts bedding in one of the dolomitic zones. The magnesium carbonate content of composite samples taken at 10-ft intervals along the entire tunnel length range from 2.32 to 17.83 percent (Table 9). Average of all the samples is 9.73 percent $MgCO_3$ and 89.60 percent $CaCO_3$. Sampling at 1-ft intervals in parts of the tunnel indicates that the $MgCO_3$ content is highly variable, ranging from 1.78 percent to 36.60 percent in less than 2 ft.

The property was acquired by Oregon Portland Cement Company as reserves for its cement plant at Lime prior to its acquisition of the Durkee quarry and the undeveloped Powell Creek deposit. The reserves at the latter two sites appear so large it seems unlikely that the Fox Creek property will be mined for many years.

Butchart property (locality F-2):

Location: Secs. 27, 28, 33, and 34, T. 11 S., R. 45 E., in the Connor Creek drainage east and northeast of the Ash Grove property and about 4 mi by dirt road up Connor Creek from its junction with the Snake River. Mineral 15-minute quadrangle.

Owner: Frank D. Butchart, Jr.

The property consists of 900 acres of unpatented mining claims located in 1950-1951 by the present owner's father. Exploration shortly thereafter included extensive surface sampling, 14 drill holes, and a few small dozer cuts. Locations of the sample sites are shown on Figure 10. The analytical results are given in Tables 10 and 11. Based on results of the drilling, a prospective quarry site of about 40 acres containing 18 million tons of high-quality limestone was proposed in the SW¼ of sec. 27. A cement plant site was selected near the mouth of Connor Creek, and a tramline was planned to carry limestone from the quarry to the cement plant. At that time, a railroad extending along the Oregon side of the Snake River could have been used to transport cement to market areas. Plans for the enterprise were dropped when construction of Brownlee Dam forced abandonment of the railroad in the mid-1950's. No mining or development has occurred subsequently.

Locations of areas sampled for this report are shown in Figure 10, and the results of analyses of samples AUB-51 through -56 and AVB-13 through -22 are given in Table 1.

North of Connor Creek, the Nelson Marble is capped by a sequence of basalt flows and basaltic tuff of Tertiary age. Where it overlaps the limestone, the Tertiary sequence has a maximum local thickness of about 500 ft.

Most of the limestone is medium to coarsely crystalline and ranges from medium gray to dark gray, with local patches, veins, and bands of nearly white limestone. The limestone appears to be of excellent quality for making cement, and some appears sufficiently pure for lime and chemical manufacture, although there are a few small areas where the limestone is high in magnesium. Because of transportation and access difficulties, it may be a long time before the limestone is of economic interest.

Upper Connor Creek (locality F-3):

Location: NE¼ sec. 29, T. 11 S., R. 45 E. Mineral 15-minute quadrangle.

Owner: U.S. Bureau of Land Management (USBLM) land. No development.

The limestone in this area ranges from dark gray to white. Most of the light-colored limestone is on the west side of the draw. Samples AUB-1, -2, -3, -31, and -32 are representative of the material available. A confident resource estimate is not possible, because quartz diorite intrudes the limestone a few hundred feet to the west and may extend beneath it in the area sampled. The whiteness of the limestone tends to increase toward the contact.

Table 9. *Chemical analyses of limestone samples from an adit on claim 6 of the Ash Grove property (locality F-1) in the Durkee-Fox Creek area. Sampling and analyses by Portland Oregon Cement Company, M.J. O'Dell, analyst. All values are in weight percent.*

Distance from portal (ft)	LOI	Insol. fraction	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	$CaCO_3$	$MgCO_3$	S	P_2O_5
1-10	--	1.34	--	0.20	0.04	--	--	90.55	8.61	0.000	0.016
11-20	--	0.48	--	0.12	0.06	--	--	94.60	5.16	0.000	0.032
21-30	--	0.92	--	0.19	0.05	--	--	93.89	5.25	0.004	0.019
31-40	--	0.50	--	0.14	0.06	--	--	89.84	10.73	0.005	0.026
41-50	--	0.64	--	0.27	0.03	--	--	89.14	10.70	0.015	0.064
51-60	--	0.72	--	0.21	0.05	--	--	92.86	6.32	0.002	0.076
61-70	--	0.60	--	0.08	0.10	--	--	84.01	15.90	0.000	0.000
71-80	--	1.18	--	0.13	0.05	--	--	87.54	11.91	0.014	0.016
81-90	--	0.90	--	0.31	0.05	--	--	92.86	6.56	0.005	0.070
91-100	--	1.00	--	0.07	0.09	--	--	96.19	2.38	0.006	0.029
102-111	43.75	--	0.38	0.25	0.05	53.90	1.11	96.19	2.32	0.00	0.023
112-121	43.28	--	1.18	0.71	0.13	53.30	1.61	95.48	3.36	0.00	0.027
122-131*	44.34	--	1.44	1.11	0.07	46.77	7.64	83.49	15.28	0.003	0.128
132-141	43.90	--	0.58	0.18	0.04	53.59	1.76	95.64	3.68	0.00	0.020
142-151*	44.53	--	0.44	1.04	0.10	46.13	8.53	82.34	17.83	0.048	0.189
152-161*	44.40	--	0.86	0.58	0.08	47.53	6.68	84.82	13.96	0.00	0.130
162-167*	44.04	--	0.94	0.91	0.17	41.36	12.15	73.82	25.39	0.00	0.170
122	--	--	--	--	--	--	--	91.84	6.83	--	--
123	--	--	--	--	--	--	--	91.39	8.49	--	--
124	--	--	--	--	--	--	--	95.52	3.90	--	--
125	--	--	--	--	--	--	--	91.13	8.86	--	--
126	--	--	--	--	--	--	--	95.52	4.70	--	--
127	--	--	--	--	--	--	--	64.82	35.53	--	--
128	--	--	--	--	--	--	--	63.05	35.95	--	--
129	--	--	--	--	--	--	--	64.12	33.40	--	--
130	--	--	--	--	--	--	--	76.72	19.33	--	--
131	--	--	--	--	--	--	--	96.44	1.78	--	--
142	--	--	--	--	--	--	--	97.60	2.32	--	--
143	--	--	--	--	--	--	--	88.40	11.33	--	--
144	--	--	--	--	--	--	--	68.49	27.80	--	--
145	--	--	--	--	--	--	--	68.13	31.70	--	--
146	--	--	--	--	--	--	--	64.58	30.33	--	--
147	--	--	--	--	--	--	--	67.24	30.78	--	--
148	--	--	--	--	--	--	--	86.77	13.01	--	--
149	--	--	--	--	--	--	--	76.13	12.98	--	--
150	--	--	--	--	--	--	--	95.82	3.57	--	--
151	--	--	--	--	--	--	--	95.10	4.71	--	--
152	--	--	--	--	--	--	--	95.46	1.51	--	--
153	--	--	--	--	--	--	--	85.37	4.01	--	--
154	--	--	--	--	--	--	--	85.60	13.51	--	--
155	--	--	--	--	--	--	--	87.18	13.21	--	--
156	--	--	--	--	--	--	--	86.26	6.93	--	--
157	--	--	--	--	--	--	--	97.93	1.80	--	--
158	--	--	--	--	--	--	--	94.21	3.85	--	--
159	--	--	--	--	--	--	--	73.85	35.35	--	--
160	--	--	--	--	--	--	--	68.80	30.64	--	--
161	--	--	--	--	--	--	--	65.65	33.18	--	--
162	--	--	--	--	--	--	--	81.60	17.65	--	--
163	--	--	--	--	--	--	--	88.20	11.08	--	--
164	--	--	--	--	--	--	--	71.05	28.25	--	--
165	--	--	--	--	--	--	--	73.65	25.35	--	--
166	--	--	--	--	--	--	--	62.40	36.60	--	--
167	--	--	--	--	--	--	--	72.60	26.10	--	--

*Individual samples of these section composites were analyzed to pinpoint heavy $MgCO_3$ deposits.

Table 10. *Chemical analyses of diamond drill cores from the Butchart property (locality F-2), Durkee-Fox Creek area. Data courtesy of Frank D. Butchart, Jr. Locations of holes are shown in Figure 10. Original drill samples were analyzed at 5-ft intervals. For this table, values have been averaged for specified intervals. All values are in weight percent.*

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 339, surface elevation 4,866 ft.		
4,866-4,860	98.51	0.44
4,860-4,855	97.62	0.66
4,855-4,850	98.87	0.34
4,850-4,845	99.04	0.42
4,845-4,840	99.04	0.42
4,840-4,835	99.04	0.42
4,835-4,830	92.88	0.23
4,830-4,825	98.87	0.47
Avg.	97.98	0.43
4,866-4,825	98.76	0.45
4,825-4,820	99.22	0.50
4,820-4,815	98.97	0.59
4,815-4,810	98.87	0.34
4,810-4,806	5.88	0.70
4,806-4,805	98.87	0.59
4,805-4,801	8.20	0.65
4,801-4,799	99.04	0.30
4,799-4,791	Basalt	
4,791-4,785	98.87	0.47
4,785-4,780	99.04	0.42
4,780-4,775	99.22	0.62
4,775-4,770	98.96	0.52
4,770-4,765	98.87	0.34
4,765-4,760	98.69	0.52
4,760-4,755	98.87	0.34
4,755-4,750	98.33	0.63
Avg.*	98.88	0.47
4,825-4,750*	99.04	0.56
4,750-4,745	98.87	0.97
4,745-4,740	98.87	0.85
4,740-4,735	98.51	0.70
4,735-4,730	98.51	1.33
4,730-4,725	98.33	0.38
4,725-4,720	98.69	1.28
4,720-4,715	98.69	0.91
4,715-4,710	98.87	0.85
4,710-4,705	98.69	0.91
4,705-4,700	98.69	1.03
4,700-4,695	97.80	0.65
4,695-4,690	99.22	0.38
4,690-4,685	98.87	0.97
4,685-4,680	98.87	0.59
Avg.	98.68	0.84
4,750-4,680	98.51	0.95
4,680-4,675	98.60	0.74
4,675-4,670	98.60	1.00
4,670-4,665	98.60	1.37
4,665-4,660	98.69	0.77
4,660-4,655	98.69	0.52
4,655-4,650	98.69	0.52
4,650-4,645	98.87	0.85
4,645-4,640	98.87	0.59
4,640-4,635	98.69	0.77
4,635-4,630	98.24	0.72
4,630-4,625	99.04	0.42
4,625-4,620	98.87	0.59
4,620-4,615	98.87	0.59
4,615-4,610	98.33	1.01
Avg.	98.68	0.75
4,680-4,610	98.51	0.82
4,610-4,605	97.08	2.76
4,605-4,600	98.33	1.51
4,600-4,595	97.08	0.59
4,595-4,590	98.87	0.59
4,590-4,585	98.87	0.59
4,585-4,580	97.98	0.47
4,580-4,575	98.87	0.59
4,575-4,570	98.87	0.59
4,570-4,565	97.80	0.65
4,565-4,560	98.87	0.47
4,560-4,555	96.72	3.00
Hole no. 339 (cont.)		
4,555-4,550	98.15	1.06
Avg.	98.27	1.07
4,610-4,550	97.80	1.54
Hole no. 341 surface elevation 4,866 ft.		
4,862-4,855	99.04	0.66
4,855-4,850	99.04	0.49
4,850-4,845	99.04	0.36
4,845-4,840	98.87	0.53
4,840-4,835	98.87	0.53
4,835-4,830	98.69	0.44
4,830-4,825	95.30	0.62
Avg.	98.40	0.52
4,862-4,855	98.96	0.40
4,825-4,820	98.96	0.30
4,820-4,815	98.87	0.75
4,815-4,810	98.87	0.75
4,810-4,805	98.33	0.93
4,805-4,800	98.87	0.53
4,800-4,795	98.69	0.71
4,795-4,790	98.15	0.71
4,790-4,785	98.15	0.71
4,785-4,780	98.51	0.89
4,780-4,775	98.69	0.71
4,775-4,770	98.69	0.71
4,770-4,765	98.51	0.89
4,765-4,760	98.51	0.49
4,760-4,755	98.51	0.75
4,755-4,750	98.51	0.62
Avg.	98.58	0.70
4,825-4,750	98.51	0.89
4,750-4,750	98.69	0.93
4,745-4,740	98.69	0.71
4,740-4,735	99.04	0.49
4,735-4,730	98.33	0.93
4,730-4,725	98.87	0.53
4,725-4,720	98.87	0.53
4,720-4,715	98.87	0.53
4,715-4,710	98.87	0.53
4,710-4,705	98.51	0.89
4,705-4,700	98.51	0.89
4,700-4,695	98.51	0.89
4,695-4,690	99.04	0.58
4,690-4,685	99.04	0.58
4,685-4,680	98.86	0.53
Avg.	98.76	0.68
4,750-4,680	98.96	0.44
4,680-4,675	98.69	0.44
4,675-4,670	98.87	0.66
4,670-4,665	98.87	0.39
4,665-4,660	98.69	0.44
4,660-4,655	98.87	0.53
4,655-4,650	98.87	0.53
4,650-4,645	98.60	0.53
4,645-4,640	98.96	0.44
4,640-4,635	98.96	0.44
4,635-4,630	98.96	0.44
4,630-4,625	98.87	0.26
4,625-4,620	98.33	0.40
4,620-4,615	98.87	0.53
Avg.	98.80	0.46
4,680-4,615	98.87	0.39
4,614-4,598	Basalt	
4,598-4,595	98.15	0.58
4,595-4,582	Mud	
4,582-4,580	98.51	0.87
4,580-4,575	98.87	0.53

*Does not include: 4,810-4,806, 4,805-4,801, and 4,799-4,791.

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 341 (cont.)		
4,575-4,570	98.87	0.39
4,570-4,565	98.60	0.53
4,565-4,560	98.51	0.35
4,560-4,555	98.51	0.49
4,555-4,551	99.04	0.36
Avg.*	98.63	0.51
4,598-4,551*	98.87	0.39

*Does not include 4,595-4,582.

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 343, surface elevation 4,870 ft.		
4,870-4,865	98.87	0.59
4,865-4,860	99.04	0.42
4,860-4,855	98.87	0.34
4,855-4,848	99.04	0.68
4,848-4,835	Basalt and mud	
4,835-4,830	98.69	0.52
4,830-4,825	98.69	0.65
Avg.*	98.86	0.53
4,870-4,825*	98.87	0.44
4,825-4,820	98.69	0.90
4,820-4,815	98.87	0.85
4,815-4,810	98.87	0.59
4,810-4,805	98.87	0.59
4,805-4,800	97.80	1.41
4,800-4,795	98.87	0.59
4,795-4,790	98.51	0.45
4,790-4,785	99.04	0.42
4,785-4,780	98.69	0.52
4,780-4,775	98.15	0.30
4,775-4,770	98.33	0.63
4,770-4,765	99.04	0.55
4,765-4,760	99.04	0.42
4,760-4,755	98.69	0.40
4,755-4,750	97.60	0.85
Avg.	98.61	0.63
4,825-4,750	98.69	0.52
4,750-4,745	96.72	0.48
4,745-4,740	98.69	0.65
4,740-4,735	98.51	1.08
4,735-4,730	98.51	0.95
4,730-4,725	98.69	0.65
4,725-4,720	98.15	1.19
4,720-4,715	98.33	0.76
4,715-4,710	98.33	0.88
4,710-4,705	98.69	0.77
4,705-4,700	98.69	0.77
4,700-4,695	98.69	0.52
4,695-4,690	98.69	1.03
4,690-4,685	98.69	0.52
4,685-4,680	98.51	0.70
Avg.	98.42	0.78
4,780-4,680	98.30	0.91
4,680-4,675	98.70	0.89
4,675-4,670	98.30	0.79
4,670-4,665	98.87	0.72
4,665-4,660	98.87	0.72
4,660-4,655	98.69	0.90
4,655-4,650	98.33	0.88
4,650-4,645	98.15	0.81
4,645-4,640	98.69	0.65
4,640-4,635	98.87	0.59
4,635-4,630	98.87	0.59
4,630-4,625	98.33	0.88
4,635-4,620	98.87	0.59
4,620-4,615	99.04	0.68
4,615-4,610	98.69	0.77
Avg.	98.66	0.75
4,680-4,610	98.60	0.74
4,610-4,605	98.87	0.47
4,605-4,600	98.87	0.59
4,600-4,595	98.87	0.59
4,595-4,590	98.87	0.59
4,590-4,585	98.87	0.59
4,585-4,580	98.15	0.30
4,580-4,575	98.51	0.71
4,575-4,570	98.44	0.52

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 343 (cont.)		
4,570-4,565	98.51	0.58
4,565-4,560	94.05	0.48
4,560-4,555	97.80	0.53
4,555-4,550	98.87	0.59
Avg.	98.22	0.54
4,610-4,550	98.51	0.58

*Does not include 4,848-4,835.

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 344, surface elevation 4,900 ft.		
4,900-4,895	98.87	0.53
4,895-4,890	98.87	0.53
4,890-4,885	98.87	0.53
4,885-4,880	99.22	0.56
4,880-4,875	99.22	0.56
4,875-4,870	99.22	0.43
4,870-4,865	99.04	0.74
4,865-4,860	99.04	0.49
4,860-4,855	98.87	0.91
4,855-4,850	99.04	0.61
4,850-4,845	98.87	0.53
4,845-4,840	98.87	0.66
4,840-4,835	98.87	0.53
4,835-4,830	98.33	0.95
4,830-4,825	98.51	0.89
Avg.	98.91	0.63
4,900-4,825	98.76	0.64
4,825-4,820	99.22	0.56
4,820-4,815	99.22	0.56
4,815-4,810	98.76	0.64
4,810-4,805	99.04	0.74
4,805-4,800	98.87	0.88
4,800-4,795	98.69	0.71
4,795-4,790	98.51	0.89
4,790-4,785	98.51	0.52
4,785-4,782	97.80	0.73
4,782-4,770	Altered basalt	
4,770-4,765	98.76	0.64
4,765-4,760	98.76	0.77
4,760-4,755	98.24	0.79
4,755-4,750	98.76	0.77
Avg.*	98.70	0.71
4,825-4,750*	98.69	0.71
4,750-4,745	98.76	0.77
4,745-4,740	98.24	0.91
4,740-4,735	94.85	2.05
4,735-4,730	99.04	0.49
4,730-4,725	99.04	0.74
4,725-4,720	98.96	0.57
4,720-4,715	99.04	0.74
4,715-4,710	99.04	0.49
4,710-4,705	98.51	0.77
4,705-4,700	98.69	0.71
4,700-4,696	Altered basalt	
4,696-4,690	98.69	0.71
4,690-4,685	99.15	0.38
4,685-4,680	93.87	5.91
Avg.*	98.14	1.17
4,750-4,680*	98.42	0.73
4,680-4,675	98.33	1.20
4,675-4,670	98.69	1.09
4,670-4,665	99.04	0.61
4,665-4,660	98.51	0.64
4,660-4,655	99.04	0.49
4,650-4,645	98.15	1.63
4,645-4,640	97.62	2.03
4,640-4,635	98.51	0.89
4,635-4,630	98.33	1.20
4,630-4,625	98.33	1.07
4,625-4,620	98.51	1.27
4,620-4,615	96.90	2.48
4,615-4,610	95.30	3.85
Avg.	98.16	1.35
4,680-4,610	97.26	2.14
4,610-4,605	90.30	9.48
4,605-4,600	96.36	2.04
4,600-4,595	97.62	1.53
4,595-4,590	97.62	1.53

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 344 (cont.)		
4,590-4,585	98.69	0.71
4,585-4,580	98.15	0.75
4,580-4,575	98.81	0.72
4,575-4,570	98.87	0.66
4,570-4,565	98.87	0.78
4,565-4,560	98.87	0.53
4,560-4,555	98.33	0.82
4,555-4,552	99.04	0.49
Avg.	97.62	1.67
4,610-4,552	97.26	2.14

*Does not include 4,782-4,770 and 4,700-4,696.

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 361, surface elevation 4,824 ft.		
4,823-4,820	62.46	37.54
4,820-4,815	72.52	27.48
4,815-4,810	91.10	8.43
4,810-4,805	82.79	17.21
4,805-4,800	65.00	35.00
4,800-4,795	74.95	25.05
4,795-4,790	97.98	0.87
4,790-4,789	53.00	3.25
4,789-4,785	98.15	0.35
4,785-4,780	98.33	0.64
4,780-4,775	91.90	6.83
4,775-4,770	98.60	0.37
4,770-4,765	98.51	0.46
4,765-4,760	98.80	0.27
4,760-4,755	98.90	0.29
4,755-4,750	98.80	0.17
Avg.	86.36	10.26
4,823-4,750*	91.99	7.65
4,750-4,745	98.50	0.23
4,745-4,740	98.30	0.20
4,740-4,735	98.50	0.23
4,735-4,730	98.60	0.13
4,730-4,725	97.98	0.17
4,725-4,720	98.07	0.19
4,720-4,715	97.80	0.47
4,715-4,710	97.80	0.23
4,710-4,705	98.60	0.23
4,705-4,700	98.33	0.72
4,700-4,695	98.15	0.90
4,695-4,690	97.90	0.82
4,690-4,685	97.20	0.96
4,685-4,680	97.54	1.29
Avg.	98.10	0.48
4,750-4,680	97.90	0.60
4,680-4,675	98.60	0.12
4,675-4,670	95.97	0.18
4,670-4,665	99.18	0.20
4,665-4,660	99.10	0.28
4,660-4,655	98.30	0.75
4,655-4,650	97.20	1.85
4,650-4,645	97.40	0.42
4,645-4,640	95.10	0.60
4,640-4,635	98.86	0.19
4,635-4,630	98.60	0.34
4,630-4,625	98.40	0.43
4,625-4,620	98.40	0.32
4,620-4,615	99.04	0.20
4,615-4,610	99.20	0.14
Avg.	98.10	0.43
4,680-4,610	98.87	0.35
4,610-4,605	98.90	0.18
4,605-4,600	98.90	0.18
4,600-4,595	98.80	0.28
4,595-4,590	99.20	0.14
4,590-4,585	98.70	0.11
4,585-4,580	98.70	0.11
4,580-4,575	98.50	0.18
4,575-4,570	98.15	0.66
4,570-4,565	98.90	0.32
4,565-4,560	99.04	0.18
4,560-4,555	98.90	0.18
4,555-4,550	98.90	0.32
Avg.	98.80	0.23
4,610-4,550	98.87	0.35

*Does not include 4,790-4,788.

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 411, surface elevation 4,726 ft.		
4,726-4,725	99.04	0.16
4,725-4,720	98.90	0.10
4,721-4,715	99.00	0.20
4,715-4,710	97.62	0.23
4,710-4,705	98.10	0.20
4,705-4,700	98.33	0.27
4,700-4,695	97.30	0.32
4,695-4,690	98.25	0.27
4,690-4,685	99.22	0.20
4,685-4,680	99.22	0.20
Avg.	98.50	0.21
4,726-4,680	99.04	0.16
4,680-4,675	99.10	0.20
4,675-4,670	99.10	0.20
4,670-4,665	98.87	0.10
4,665-4,661	98.70	0.27
4,659-4,655	98.20	0.30
4,655-4,650	98.70	0.27
4,650-4,645	99.30	0.12
4,645-4,640	97.98	0.10
4,640-4,635	98.60	0.15
4,635-4,630	99.40	0.14
4,630-4,625	99.00	0.20
4,625-4,620	99.20	0.10
4,620-4,615	99.10	0.10
4,615-4,610	99.20	-0-
Avg.	98.89	0.16
4,680-4,610	98.98	0.28
4,610-4,605	99.10	0.10
4,605-4,600	99.00	0.36
4,600-4,595	99.20	0.29
4,595-4,590	99.10	0.62
4,590-4,585	99.28	0.44
4,585-4,582	99.28	0.44
4,582-4,579	76.64	23.51
4,579-4,575	98.70	0.79
4,575-4,570	98.90	0.59
4,570-4,565	99.10	0.26
4,565-4,560	99.10	0.29
4,560-4,555	99.30	0.19
4,555-4,549	99.40	0.05
Avg.	97.40	2.15
4,610-4,549	98.33	1.39
Hole no. 433, surface elevation 4,762 ft.		
4,762-4,760	99.10	0.16
4,760-4,755	98.90	0.14
4,755-4,750	98.60	0.20
Avg.	98.86	0.17
4,762-4,750	98.90	0.25
4,750-4,740	99.00	0.15
4,740-4,735	99.10	0.16
4,735-4,730	99.10	0.16
4,730-4,725	98.80	0.12
4,725-4,720	99.20	0.27
4,720-4,715	99.22	0.38
4,715-4,710	98.70	0.13
4,710-4,705	98.69	0.15
4,705-4,700	99.00	0.06
4,700-4,695	98.80	0.15
4,695-4,690	98.60	0.12
4,690-4,685	99.04	0.16
4,685-4,680	98.85	0.10
Avg.	98.93	0.16
4,750-4,680	98.87	0.19
4,680-4,675	98.84	0.11
4,675-4,670	98.40	0.10
4,670-4,665	98.69	0.03
4,665-4,660	98.40	0.10
4,660-4,655	98.20	0.06
4,655-4,650	98.60	0.12
4,650-4,645	98.76	0.08
4,645-4,640	98.50	0.11
4,640-4,635	98.00	0.26
4,635-4,630	98.90	0.05
4,630-4,625	98.15	0.11
4,625-4,620	98.60	0.12
4,620-4,615	98.48	0.13
4,615-4,610	98.81	0.08
Avg.	98.53	0.10

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 433 (cont.)		
4,680-4,610	98.69	0.12
4,610-4,605	97.62	0.19
4,605-4,600	98.62	0.10
4,600-4,595	98.51	0.21
4,595-4,590	98.51	0.10
4,590-4,585	98.69	0.03
4,585-4,580	98.60	0.12
4,580-4,575	98.69	0.03
4,575-4,573	98.51	0.21
4,573-4,568	Void space in rock	
4,568-4,565	98.69	0.15
Avg.	98.46	0.13
4,610-4,565	98.96	0.13
Hole no. 435, surface elevation 4,697 ft.		
4,697-4,689	Overburden	
4,689-4,685	98.90	0.25
4,685-4,680	99.50	0.10
Avg.	99.20	0.17
4,689-4,680	99.40	0.20
4,680-4,675	98.90	0.36
4,675-4,670	98.90	0.46
4,670-4,665	98.80	0.24
4,665-4,660	99.30	0.30
4,660-4,655	99.30	0.19
4,655-4,650	98.67	0.13
4,650-4,645	99.10	0.39
4,645-4,640	92.30	0.20
4,640-4,635	98.80	0.14
4,635-4,630	99.05	0.10
4,630-4,625	98.60	0.20
4,625-4,620	99.00	0.26
4,620-4,615	98.60	0.12
4,615-4,610	98.90	0.16
Avg.	98.44	0.23
4,680-4,610	98.51	0.21
4,610-4,607	98.90	0.05
4,607-4,605	97.20	0.38
4,605-4,600	98.40	0.09
4,600-4,595	98.15	0.11
4,595-4,590	93.16	0.54
4,590-4,585	97.50	0.20
4,585-4,580	91.55	0.16
4,580-4,575	98.60	0.12
4,575-4,570	98.80	0.15
4,570-4,567	91.47	6.00
4,567-4,560	98.50	0.11
4,560-4,555	97.62	0.64
4,555-4,550	98.42	0.30
Avg.	96.79	0.68
4,610-4,550	97.35	0.35
Hole no. 436, surface elevation 4,715 ft.		
4,715-4,710	99.20	0.10
4,710-4,705	99.04	0.16
4,705-4,700	99.04	0.16
4,700-4,695	99.04	0.16
4,695-4,690	99.04	0.31
4,690-4,685	99.20	0.10
4,685-4,680	99.20	0.10
Avg.	99.11	0.16
4,715-4,680	99.04	0.16
4,680-4,675	99.04	0.16
4,675-4,670	99.04	0.16
4,670-4,665	98.50	0.40
4,665-4,660	98.50	0.30
4,660-4,655	98.50	0.40
4,655-4,650	99.00	0.20
4,650-4,645	99.04	0.26
4,645-4,640	98.70	0.40
4,640-4,630	99.04	0.16
4,630-4,625	99.04	0.26
4,625-4,620	99.20	0.10
4,620-4,615	98.90	0.20
4,615-4,610	98.80	0.17
Avg.	98.88	0.24
4,680-4,610	98.70	0.30

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 436 (cont.)		
4,610-4,605	99.30	0.12
4,605-4,600	99.10	0.10
4,600-4,595	98.00	0.07
4,595-4,590	99.36	0.06
4,590-4,585	97.30	0.10
4,585-4,580	99.30	0.12
4,580-4,575	98.87	0.10
4,575-4,570	99.10	0.10
4,570-4,565	99.60	0.05
4,565-4,560	99.35	0.07
4,560-4,555	98.85	0.12
4,555-4,550	99.10	0.10
Avg.	98.89	0.09
4,610-4,550	98.87	0.10
Hole no. 438, surface elevation 4,702 ft.		
4,702-4,700	99.10	0.32
4,700-4,695	99.20	0.22
4,695-4,690	99.00	0.20
4,690-4,685	98.87	0.33
4,685-4,680	99.00	0.20
Avg.	99.03	0.25
4,702-4,680	99.30	0.19
4,680-4,675	99.00	0.20
4,675-4,670	98.80	0.17
4,670-4,665	99.10	0.10
4,665-4,660	98.70	0.27
4,660-4,655	95.83	3.14
4,655-4,650	97.10	2.10
4,650-4,645	98.40	0.80
4,645-4,640	98.60	0.82
4,640-4,635	98.69	0.51
4,635-4,630	98.90	0.37
4,630-4,625	99.20	0.29
4,625-4,620	99.10	0.17
4,620-4,615	99.00	0.15
4,615-4,610	98.70	0.34
Avg.	98.51	0.67
4,680-4,610	97.44	1.60
4,610-4,605	99.40	0.09
4,605-4,600	99.27	0.45
4,600-4,595	99.10	0.39
4,595-4,590	99.10	0.39
4,590-4,585	99.10	0.39
4,585-4,580	99.10	0.39
4,580-4,575	99.10	0.39
4,575-4,565	98.00	0.80
4,565-4,560	96.96	1.28
4,560-4,555	97.40	1.18
4,555-4,552	97.90	0.90
Avg.	98.53	0.62
4,610-4,552	98.90	0.46
Hole no. 461, surface elevation 4,768 ft.		
4,768-4,765	98.87	0.19
4,765-4,760	98.51	0.10
4,760-4,759	96.54	0.13
4,759-4,755	Clay	
4,755-4,750	99.10	0.20
Avg.	98.25	0.16
4,768-4,750	98.51	0.24
4,750-4,745	99.13	0.06
4,745-4,740	99.04	0.15
4,740-4,735	98.60	0.15
4,735-4,730	98.80	0.15
4,730-4,725	98.20	0.07
4,725-4,720	98.65	0.10
4,720-4,715	98.69	0.16
4,715-4,710	98.66	0.09
4,710-4,705	97.40	0.30
4,705-4,700	97.40	0.41
4,700-4,695	99.10	0.09
4,695-4,690	98.87	0.20
4,690-4,685	98.42	0.08
4,685-4,680	98.20	0.18
Avg.	98.51	0.16
4,750-4,680	98.42	0.19

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 461 (cont.)		
4,680-4,675	97.60	0.09
4,675-4,670	98.50	0.10
4,670-4,665	99.04	0.15
4,665-4,660	98.76	0.21
4,660-4,655	98.76	0.21
4,655-4,650	99.13	0.06
4,650-4,645	99.13	0.06
4,645-4,640	98.50	0.22
4,640-4,635	98.87	0.32
4,635-4,630	98.87	0.32
4,630-4,625	99.04	0.15
4,625-4,620	99.13	0.06
4,620-4,615	99.04	0.15
4,615-4,610	91.99	0.54
Avg.	98.31	0.19
4,680-4,610	98.96	0.23
4,610-4,605	98.96	0.11
4,605-4,600	98.50	0.23
4,600-4,595	98.50	0.35
4,595-4,590	97.00	2.30
4,590-4,585	98.87	0.32
4,585-4,580	99.31	0.09
4,580-4,575	98.50	0.23
4,575-4,570	98.20	0.30
4,570-4,565	97.50	0.30
4,565-4,560	98.76	0.21
4,560-4,555	98.40	0.33
4,555-4,550	98.80	0.17
4,550-4,548	98.96	0.60
Avg.	98.48	0.43
4,610-4,548	98.87	0.20
Hole no. 465, surface elevation 4,610 ft.		
4,610-4,605	89.19	0.28
4,605-4,600	90.08	0.56
4,600-4,595	96.45	0.71
4,595-4,590	97.20	0.70
4,590-4,585	96.30	0.60
4,585-4,580	96.45	0.71
4,580-4,575	97.53	0.77
4,575-4,570	98.96	0.44
4,570-4,565	98.42	0.48
4,565-4,560	98.33	0.32
4,560-4,555	98.15	0.50
4,555-4,550	98.76	0.40
Avg.	96.31	0.53
4,610-4,550	97.89	0.41
Hole no. 466, surface elevation 4,620 ft.		
4,620-4,615	99.04	0.74
4,615-4,610	98.87	0.91
Avg.	98.95	0.83
4,620-4,610	99.04	0.74
4,610-4,605	99.22	0.68
4,605-4,600	99.22	0.68
4,600-4,595	98.69	0.55
4,595-4,590	99.04	0.61
4,590-4,585	99.04	0.61
4,585-4,580	Void	
4,580-4,575	99.13	0.52
4,575-4,570	98.60	0.44
4,570-4,565	98.69	0.55
4,565-4,560	98.15	0.50
4,560-4,555	99.07	0.58
4,555-4,550	99.31	0.59
Avg.	98.92	0.67
4,610-4,550	98.96	0.57

Interval elevation (ft)	$CaCO_3$	$MgCO_3$
Hole no. 491, surface elevation 4,835 ft.		
4,835-4,830	98.87	0.47
4,830-4,825	99.30	0.18
4,825-4,820	98.80	0.14
4,820-4,815	99.04	0.18
Avg.	99.00	0.24
4,835-4,815	99.04	0.18
4,815-4,789	Basalt, altered basalt (mostly calcium silicates) and mud	
4,789-4,785	99.04	0.18
4,785-4,780	99.04	0.18
4,780-4,775	99.20	0.14
4,775-4,770	99.20	0.54
4,770-4,765	99.40	0.21
4,765-4,760	99.00	0.34
4,760-4,755	98.96	0.26
4,755-4,750	99.04	0.66
Avg.	99.11	0.31
4,789-4,750	99.04	0.30
4,750-4,745	99.04	0.49
4,745-4,740	98.51	0.62
4,740-4,735	98.51	1.02
4,735-4,730	98.51	0.62
4,730-4,725	98.33	0.52
4,725-4,720	62.90	0.30
4,720-4,715	98.76	0.50
4,715-4,710	97.26	0.26
4,710-4,705	96.18	0.54
4,705-4,700	99.04	0.58
4,700-4,695	98.51	0.62
4,695-4,690	98.33	0.53
4,690-4,685	97.44	0.48
4,685-4,680	98.70	0.43
Avg.	95.71	0.54
4,750-4,680	97.98	0.62
4,680-4,675	98.15	0.45
4,675-4,670	95.83	0.37
4,670-4,665	98.51	0.62
4,665-4,660	98.15	0.15
4,660-4,655	98.15	0.85
4,655-4,650	71.20	3.75
4,650-4,645	98.33	1.29
4,645-4,640	98.15	1.47
4,640-4,635	98.87	0.53
4,635-4,630	98.33	1.20
4,630-4,625	93.16	6.74
4,625-4,620	97.35	2.05
4,620-4,615	97.98	1.42
4,615-4,610	98.87	1.03
Avg.	95.78	1.57
4,680-4,610	96.90	1.69
4,610-4,605	99.22	0.33
4,605-4,600	99.22	0.40
4,600-4,595	98.87	0.53
4,595-4,590	98.69	0.57
4,590-4,585	98.42	1.20
4,585-4,580	98.51	1.37
4,580-4,575	98.87	0.75
4,575-4,570	99.04	0.58
4,570-4,565	98.87	0.53
4,565-4,560	98.69	0.44
4,560-4,555	98.69	0.71
4,555-4,549	98.69	0.44
Avg.	98.81	0.65
4,610-4,549	98.76	0.64

Table 11. *Chemical analyses of limestone samples from the Butchart property (locality F-2), Durkee-Fox Creek area. Data courtesy of Frank D. Butchart, Jr. Locations of samples are shown in Figure 10. All values are in weight percent.*

Sample no.	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO*
300	0.25	0.05	0.19	55.13	0.09
301	0.21	0.04	0.10	55.13	Tr
302	0.19	0.04	0.08	55.33	Tr
303	0.19	0.05	0.13	55.13	Tr
304	0.15	0.04	0.10	55.43	Tr
305	0.19	0.05	0.15	55.13	Tr
306	0.25	0.03	0.21	54.56	0.86
307	0.60	0.04	0.20	53.16	1.99
308	0.12	0.03	0.14	55.26	0.55
309	0.35	0.03	0.27	55.36	0.14
310	0.34	0.03	0.31	55.26	0.16
311	0.33	0.05	0.39	54.96	0.12
312	0.11	0.04	0.12	55.65	0.09
318	0.18	0.04	0.12	55.26	0.07
319	0.49	0.03	0.09	55.26	0.07
320	0.11	0.04	0.18	55.46	0.08
321	0.20	0.04	0.26	55.06	0.18
322	0.21	0.04	0.22	55.36	0.14
323	0.15	0.04	0.20	55.46	0.08
324	0.21	0.03	0.29	55.06	0.10
325	0.09	0.02	0.14	55.61	0.03
326	0.29	0.22	0.46	43.00	10.97
327	3.09	0.46	0.44	33.54	17.36
328	4.70	0.50	0.58	34.15	16.44
329	0.26	0.06	0.20	54.56	0.73
330	1.20	0.12	0.42	33.33	18.53
331	0.43	0.05	0.27	52.66	2.53
332	0.28	0.14	0.26	49.30	5.07
333	0.22	0.12	0.30	47.52	7.24
334	0.34	0.05	0.49	49.65	4.67
335	0.35	0.16	0.44	53.94	0.92
336	0.39	0.10	0.30	53.20	1.91
337	0.81	0.11	0.37	54.00	0.85
338	0.22	0.08	0.18	51.80	3.22
339	5.42	0.18	0.52	51.60	0.51
340	0.10	0.04	0.08	55.60	0.03
341	0.14	0.03	0.07	55.44	0.18
342	0.22	0.04	0.08	55.40	0.16
343	0.32	0.07	0.29	54.97	0.23
344	0.16	0.04	0.12	55.43	0.08
345	0.18	0.05	0.07	55.30	0.08
346	0.24	0.04	0.22	55.34	0.21
347	0.22	0.04	0.14	55.40	0.16
348	0.36	0.06	0.26	54.85	0.40
349	0.30	0.03	0.21	55.20	0.29
350	0.30	0.03	0.15	55.35	0.14
351	0.34	0.03	0.13	55.20	0.20
352	0.32	0.20	0.42	54.50	0.54
353	80.96	4.29	8.61	0.22	0.57
354	75.60	1.92	8.88	1.00	1.16
355	0.20	0.05	0.15	55.20	0.24
356	0.16	0.04	0.21	55.32	0.13
357	0.36	0.08	0.30	54.95	0.29
358	0.20	0.05	0.23	55.42	0.09
359	0.24	0.04	0.18	55.10	0.25
360	0.16	0.05	0.30	55.32	0.15
361	0.24	0.05	0.29	55.22	0.24
362	0.40	0.36	0.20	34.33	15.19
363	0.46	0.08	0.12	54.92	0.20
364	1.62	0.39	0.13	54.11	0.35
365	0.36	0.06	0.40	54.32	0.67
366	0.50	0.12	0.34	36.42	16.10
367	0.70	0.26	0.34	33.33	18.86
368	3.78	0.77	0.15	51.80	1.01
369	32.00	2.48	2.20	26.34	8.79
370	0.52	0.08	0.34	51.80	2.89
371	0.28	0.10	0.44	54.32	0.89
372	88.80	0.95	5.49	0.14	0.54
373	88.86	3.34	8.34	0.40	0.77
374	0.28	0.05	0.25	54.87	0.38
375	0.24	0.06	0.20	52.26	2.93
376	0.22	0.05	0.23	54.96	0.33
377	0.34	0.08	0.40	54.06	0.90
378	0.74	0.48	0.70	35.24	16.69
379	0.44	0.12	0.34	43.37	10.25
380	0.64	0.24	0.46	46.02	7.90
382	0.50	0.26	0.34	53.72	1.07
384	0.56	0.08	0.48	53.61	1.12
404	0.52	0.10	0.20	54.82	0.22
411	0.34	0.04	0.14	55.32	0.15
412	0.30	0.08	0.20	55.16	0.24
413	0.28	0.04	0.20	55.36	0.13
414	0.18	0.04	0.20	55.36	0.12
415	0.24	0.04	0.14	55.12	0.20
416	0.18	0.03	0.13	55.42	0.10
417	0.18	0.06	0.18	55.46	Tr
418	0.28	0.04	0.20	55.42	0.08
419	0.24	0.03	0.13	55.52	Tr
420	0.16	0.03	0.17	55.66	Tr
421	0.18	0.04	0.14	55.56	Tr
422	0.24	0.04	0.20	55.22	0.26
423	0.16	0.03	0.16	55.42	0.10
424	0.22	0.05	0.13	55.42	Tr
425	0.14	0.03	0.19	55.42	0.08
426	1.78	0.15	0.09	54.62	0.07
427	0.48	0.08	0.28	54.82	0.24
428	0.26	0.06	0.24	55.47	0.06
429	0.24	0.06	0.26	55.42	Tr
430	0.18	0.08	0.16	55.47	Tr
431	0.22	0.04	0.18	55.42	Tr
432	0.22	0.08	0.20	53.13	1.95
433	0.28	0.08	0.12	55.22	0.08
434	0.62	0.20	0.44	45.05	8.53
435	0.20	0.04	0.14	55.32	0.12
436	0.30	0.06	0.16	55.02	0.31
437	2.30	0.08	0.16	54.28	Tr
438	0.14	0.04	0.18	55.52	Tr
439	0.52	0.08	0.14	54.82	0.32
440	0.72	0.10	0.26	54.76	0.40
441	0.90	0.18	0.32	54.11	0.61
442	0.16	0.04	0.18	55.56	Tr
443	0.32	0.03	0.15	55.36	Tr
444	0.32	0.06	0.10	55.26	0.10
445	0.34	0.06	0.22	55.26	0.13
446	7.18	0.20	0.22	51.36	0.08
447	0.16	0.06	0.14	55.36	0.08
448	0.28	0.08	0.18	55.11	0.14
449	1.22	0.12	0.24	54.36	0.43
450	0.28	0.10	0.22	55.16	0.21
451	0.40	0.22	0.40	54.76	0.40
452	0.14	0.06	0.16	55.36	0.11
453	0.22	0.10	0.16	55.21	0.08
455	0.30	0.08	0.24	55.16	0.06
456	0.20	0.08	0.14	55.36	0.08
457	0.26	0.08	0.14	55.26	0.11
458	0.20	0.03	0.23	55.56	Tr
459	0.30	0.04	0.22	55.16	0.13
460	0.52	0.10	0.22	55.11	0.22
461	0.28	0.06	0.18	55.46	Tr
462	0.16	0.04	0.18	55.56	Tr
463	0.18	0.06	0.16	55.56	Tr
464	0.14	0.03	0.17	55.51	Tr
465	2.68	0.10	0.10	54.16	0.19
466	0.12	0.04	0.12	55.31	0.33
467	0.22	0.08	0.12	55.16	0.29
468	0.24	0.06	0.22	55.36	Tr
469	0.22	0.06	0.20	55.46	Tr
470	0.22	0.04	0.20	55.36	0.10
471	0.32	0.10	0.26	55.16	0.24
472	0.58	0.20	0.20	54.96	0.24
473	0.24	0.03	0.17	55.56	0.08
474	0.36	0.08	0.20	55.06	0.27
475	13.70	0.20	0.24	47.35	0.53
476	0.52	0.10	0.20	54.86	0.31
477	0.24	0.06	0.22	55.26	0.10
478	0.32	0.10	0.26	55.06	0.26
479	0.22	0.08	0.20	55.26	0.20
480	0.22	0.03	0.03	55.56	Tr
481	0.12	0.04	0.10	55.56	Tr
482	0.34	0.10	0.24	54.86	0.44

*Tr = trace

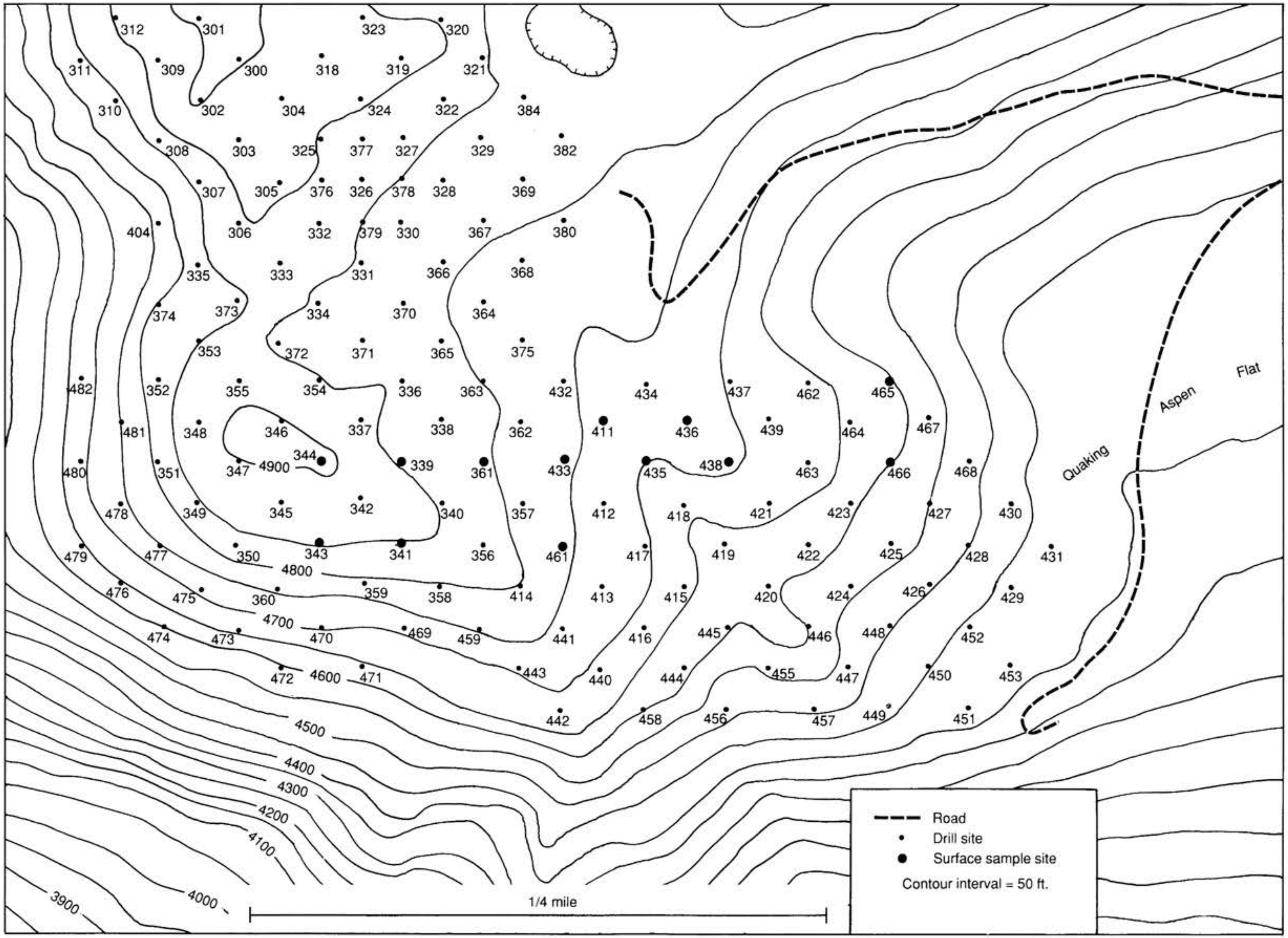

Figure 10. Map showing location of surface sample and drill sites, Butchart property (locality F-2), Durkee-Fox Creek area, SW¼ sec. 27, T.11 S., R. 45 E. Analytical data are presented in Tables 10 and 11.

Summit Creek (locality F-4):

Location: SW¼ sec. 1, T. 12 S., R. 44 E. Durkee 15-minute quadrangle.

Owner: Not determined. No development.

An exposure of the Nelson Marble in this area near the head of Summit Creek was sampled by the Oregon Portland Cement Company in May 1958. Analytical results of the samples are given in Table 12. Three sample traverses reportedly paralleling the jeep road that crosses the exposure were made, but record of the exact locations of the samples has been lost. Sample results show that a major portion of the marble is too high in magnesium to warrant development of the deposit for use in cement, but it may be considered a source of dolomite.

Sisley Creek (locality F-5):

Location: Large exposures of the Nelson Marble occur in the Sisley Creek drainage, mostly in secs. 2 and 3, T. 12 S., R. 44 E. Durkee 15-minute quadrangle.

Owner: Not determined. No development.

In 1958, the Oregon Portland Cement Company collected and analyzed 162 samples from an exposure near the top of the northeast-trending ridge in the SE¼ sec. 3. Access is via jeep road up Hogback Creek. The area sampled is about 1,600 ft long in an east-west direction and 400 ft wide. The calcium and magnesium carbonate contents of the samples are shown in Table 13. Composite average of the analyses was 94.92 percent $CaCO_3$ and 1.56 percent $MgCO_3$. The analyses indicate that most of the exposed material is good quality for cement. Six samples contained more than 3 percent $MgCO_3$. The remainder ranged from 0.29 to 2.00 percent $MgCO_3$.

Table 12. *Chemical analyses of samples from the Summit Creek deposit (locality F-4), Durkee-Fox Creek area. Chemical analyses by M.J. O'Dell in 1958. All values are in weight percent.*

Sample	$CaCO_3$	$MgCO_3$
SU - 1	98.46	0.98
SU - 2	97.48	1.39
SU - 3	99.19	0.77
SU - 4	99.37	0.59
SU - 5	83.77	15.63
SU - 6	61.34	37.91
SU - 7	88.09	10.55
SU - 8	63.67	35.91
SU - 9	75.52	21.70
SU -10	94.18	5.85
SU -11	91.04	8.72
SU -12	92.08	7.23
SU -13	88.56	10.09
SU -14	97.58	1.65
SU -15	98.29	1.11
SU2- 1	98.31	1.17
SU2- 2	97.42	1.09
SU2- 3	99.30	0.60
SU2- 4	99.05	0.77
SU2- 5	97.95	1.98
SU2- 6	62.41	37.26
SU2- 7	75.52	24.14
SU2- 8	85.95	13.36
SU2- 9	83.63	16.20
SU2-10	86.22	13.29
SU2-11	87.40	12.12
SU2-12	89.16	10.13
SU2-13	92.53	7.73
SU2-14	92.09	7.99
SU2-15	91.37	7.19
SU3- 1	98.74	1.13
SU3- 2	97.94	1.63
SU3- 3	98.83	1.46
SU3- 4	97.15	1.15
SU3- 5	88.18	11.64
SU3- 6	70.88	20.51
SU3- 7	51.29	24.47
SU3- 8	65.00	32.48
SU3- 9	95.57	4.37
SU3-10	89.16	10.05
SU3-11	97.26	1.88
SU3-12	85.39	10.14

Table 13. *Chemical analyses of samples from the Sisley Creek deposit (locality F-5), Durkee-Fox Creek area. Chemistry by M.J. O'Dell in 1958. All values are in weight percent.*

Sample	$CaCO_3$	$MgCO_3$
A- 1	98.24	1.09
A- 2	99.40	0.29
A- 3	97.53	0.82
A- 4	97.97	0.99
A- 5	98.20	0.83
A- 6	97.35	1.46
A- 7	68.01	29.55
A- 8	98.65	0.98
A- 9	97.11	1.15
A-10	97.53	1.57
A-11	98.20	1.69
A-12	98.73	1.07
A-13	98.24	1.71
A-14	98.43	1.48
A-15	97.64	1.09
A-16	98.64	1.23
A-17	98.27	1.55
A-18	98.13	1.40
A-19	98.13	1.33
A-20	98.58	1.27
A-21	98.15	1.13
B- 1	98.33	0.83
B- 2	98.87	0.55
B- 3	99.05	0.83
B- 4	98.56	1.26
B- 5	98.03	1.79
B- 6	98.69	1.09
B- 7	98.69	0.92
B- 8	98.53	0.98
B- 9	98.92	0.65
B-10	98.73	0.88
B-11	98.33	1.13
B-12	98.35	0.63
B-13	98.73	1.09
B-14	99.01	0.59
C- 1	98.92	0.96
C- 2	98.15	0.89
C- 3	98.32	1.63
C- 4	97.57	1.07
C- 5	98.84	0.96
C- 6	98.36	0.61
C- 7	98.45	0.52
C- 8	97.36	1.15
C- 9	98.75	0.92
C-10	97.90	1.11
D- 1	98.22	0.77
D- 2	98.66	0.00
D- 3	99.22	0.90
D- 4	98.59	0.69
D- 5	98.52	1.34
D- 6	98.50	0.54
D- 7	92.51	0.65
D- 8	98.75	0.79
D- 9	98.99	0.75
D-10	99.15	0.82

Sample	$CaCO_3$	$MgCO_3$
D-11	99.06	0.94
D-12	98.99	1.02
E- 1	91.02	0.15
E- 2	98.90	0.40
E- 3	99.38	0.31
E- 4	95.24	0.23
E- 5	94.86	0.36
E- 6	90.79	0.36
E- 7	98.45	0.48
E- 8	98.59	0.65
E- 9	98.29	0.77
E-10	98.75	1.14
E-11	97.74	0.86
E-12	98.22	0.69
E-13	No samples	
E-14	98.36	1.00
E-15	99.61	0.69
E-16	98.59	0.96
E-17	90.63	1.17
E-18	98.36	0.86
F- 1	97.90	0.52
F- 2	98.91	0.48
F- 3	97.66	1.07
F- 4	97.49	0.75
F- 5	98.06	0.61
F- 6	99.22	0.67
F- 7	98.75	0.63
F- 8	98.52	0.88
F- 9	98.52	1.09
F-10	98.45	1.05
G- 1	96.60	1.17
G- 2	96.51	0.87
G- 3	98.73	1.17
G- 4	97.19	0.65
G- 5	96.42	3.11
H- 1	85.61	11.47
K- 1	91.17	0.38
K- 2	97.49	0.98
K- 3	95.87	0.75
K- 4	97.01	0.92
K- 5	93.11	0.67
K- 6	98.65	1.29
K- 7	97.41	2.00
K- 8	97.49	1.11
K- 9	97.30	1.37
K-10	98.46	0.63
K-11	95.57	1.30
K-12	97.12	1.25
K-13	95.59	0.73
K-14	96.73	1.30
L- 1	98.35	0.48
L- 2	98.74	0.87
L- 3	98.36	1.42
L- 4	98.55	1.27
L- 5	98.64	1.71
L- 6	97.97	1.85
L- 7	7.10	0.96
L- 8	98.26	0.75
L- 9	17.10	0.80
L-10	90.70	8.15
L-11	95.10	0.92
L-12	97.68	1.13
L-13	98.83	1.11
L-14	98.02	1.85
M- 1	95.39	1.15
M- 2	98.40	1.48
M- 3	98.56	0.85
M- 4	94.16	0.90
M- 5	98.56	0.88
M- 6	98.76	1.07
M- 7	99.03	0.90
M- 8	98.76	0.96

Sample	$CaCO_3$	$MgCO_3$
M- 9	98.04	1.50
M-10	98.40	1.23
M-11	98.22	1.57
M-12	4.16	1.09
M-13	75.37	7.94
N- 1	97.95	0.79
N- 2	98.97	0.79
N- 3	98.81	0.92
N- 4	98.57	0.69
N- 5	97.86	1.25
N- 6	98.88	0.42
N- 7	96.93	0.92
N- 8	1.95	0.31
N- 9	80.67	19.49
N-10	98.57	0.88
N-11	96.79	1.38
N-12	99.11	0.59
N-13	98.65	0.75
N-14	98.57	1.09
N-15	98.41	0.75
P- 1	97.41	0.73
P- 2	96.47	0.56
P- 3	98.81	0.77
P- 4	98.25	0.69
P- 5	96.56	0.67
P- 6	97.29	0.90
P- 7	91.92	8.12
P- 8	98.06	0.71
P- 9	92.54	6.44
P-10	98.29	1.17
P-11	97.52	1.97
P-12	98.68	1.13
P-13	97.36	1.57
P-14	97.82	1.59
P-15	98.75	0.79

Durkee quarry (locality F-6):

Location: The quarry is in secs. 10 and 15, T. 12 S., R. 43 E. The cement plant is in sec. 11, T. 12 S., R. 43 E., about 1 mi east of the quarry and adjacent to I-84 and the Union Pacific Railroad about 28 mi southeast of Baker.

Owner: Ash Grove Cement West, Inc.

The property consists of 1,158 acres composed of a mix of deeded land and both patented and unpatented mining claims. The limestone quarry area covers 22 acres, and the shale quarry covers 5 acres. Figures 11 and 12 are photos of plant and quarry area.

Figure 11. Cement plant and quarry of the Ash Grove Cement West Company operation near Durkee. View to west.

Figure 12. Durkee quarry (locality F-6) and stockpiles. Primary crusher and screening facility in middle ground. Stockpiles to left are screened sugar rock in front and cement rock in rear.

Limestone from a site across the highway from the cement plant was burned for local construction needs early in the century. Development of the present quarry was started in 1953 by Morrison Knudsen Company. National Industrial Products Corporation was formed as the operating company in early 1954. Initially, most of the product was shipped by rail for use by sugar refineries in Idaho and Oregon. Because the sugar refineries require screened, high-quality limestone of a certain size range, large amounts of undersize and subgrade stone accumulated in stockpiles. In September 1959, Oregon Portland Cement Company bought Morrison Knudsen Company's share of the property and began utilizing the latter material in its cement manufacturing operation at Lime and Lake Oswego. The sugar-rock markets have been maintained and in recent years have expanded. Between 1985 and 1988, sugar-rock sales averaged close to 228,000 tons per year.

Construction of the cement plant at Durkee began in July 1977. It became fully operational in February 1980. Total cost of construction was about $47 million.

Total limestone production of the Durkee quarry through 1988 is shown in Table 14. About 65 percent of this production was used in cement, and 35 percent was sold to others. Most of the latter was sold to sugar refineries operated by Amalgamated Sugar Company in Nyssa, Oregon, and near Nampa, Twin Falls, and Paul, Idaho. Significant amounts of high-quality stone from the Durkee quarry have also been used for agricultural purposes and glass manufacture.

The limestone is uniformly bluish gray and crystalline. Analyses AVB-81 and -82 in Table 1 represent grab samples of sugar rock from stockpiles. The grade of the sugar rock is maintained at greater than 98 percent $CaCO_3$.

Shale and clay for use in manufacturing cement are mined from a pit on company property less than half a mile east of the limestone quarry.

The quarry face is 600 ft high. It is developed by thirteen working benches. Bench faces are maintained as close to vertical as practical, forming a 75° angle from the horizontal plane. Bench widths are maintained at 35 ft, with vertical intervals at 45 ft. This bench pattern is designed to give an overall backslope of 44°. In about two more years, the benches will be to the quarry floor, and the quarry method will have to be changed.

Table 14. *Limestone produced from the Durkee quarry (locality F-6), Durkee-Fox Creek area.*

Year	Shipped to other users (tons)	Used by Oregon Portland Cement Company until 1959 and then by Ash Grove Cement West, Inc., for cement manufacture (tons)
1953	15,203.98	--
1954	84,368.46	17,821.02
1955	104,484.97	64,476.37
1956	110,855.47	71,198.65
1957	138,674.22	78,788.51
1958	110,195.59	64,734.81
1959	73,069.41*	--*
1959	72,191.95*	42,305.99*
1960	134,103.88	271,740.14
1961	131,645.94	297,275.55
1962	147,563.47	181,227.04
1963	153,197.19	231,062.00
1964	168,348.23	168,481.00
1965	136,702.24	229,557.00
1966	133,504.74	269,594.00
1967	133,371.66	266,568.49
1968	127,815.27	217,488.00
1969	155,312.84	183,875.20
1970	176,384.49	176,290.00
1971	133,882.53	187,614.00
1972	130,611.38	223,377.00
1973	149,547.57	257,691.00
1974	145,256.09	224,879.00
1975	112,695.33	259,989.00
1976	155,139.45	264,175.00
1977	108,700.05	244,447.00
1978	112,173.53	255,564.00
1979	69,874.37	304,368.00
1980	92,164.39	516,529.00
1981	117,257.81	498,257.00
1982	109,782.30	387,900.00
1983	156,664.34	545,699.00
1984	208,736.08	544,448.00
1985	215,408.00	575,144.00
1986	225,425.00	515,501.00
1987	243,454.00	581,400.00
1988	228,450.00	578,609.00
Total	5,237,624.33	10,376,218.77

Total production: 15,613,842 tons.

*Quarry changed ownership in 1959, so two sets of figures are published for that year.

An air-circulated rotary drill is used to drill 7¼-in. by 48-ft blast holes, and ammonium nitrate is used for blasting. The quarry is shot at two-week intervals providing about 60,000 tons per blast.

Rock from the quarry is sized by screening and crushing. The minus 2.5-in. rock is used to make cement. From the plus 2.5-in. rock, three different sizes of sugar rock are produced for the Alamagated Sugar Company: 1.5 by 2.5 in., 2.5 by 3.5 in., and 3.5 by 4.5 in.

When constructed, the Durkee plant was the first dry-process cement plant in the Pacific Northwest equipped with a preheater rotary kiln. Process equipment and operating conditions are monitored electronically in a central control room. The inside of the kiln and the raw mill and finish mill are monitored with color-television cameras. The kiln is 216 ft 6 in. long and 14 ft 3 in. in diameter and has a rated capacity of 1,500 tons of clinker per day.

Company reports indicate that limestone reserves in and adjacent to the quarry are sufficient for about 50 years of operation at the present rate of production.

Powell Creek (locality F-7):

Location: Secs. 7 and 8, T. 12 S., R. 43 E., about 3.3 air mi west of the cement plant at Nelson and 3 mi south of Burnt River. The deposit is cut by Powell Creek. Durkee 15-minute quadrangle and adjoining Lost Basin 7½-minute quadrangle.

Owner: Eight mining claims located in November 1986 by Ash Grove Cement West, Inc., cover exposures on the east side of Powell Creek. Exposures west of the creek are on private land owned by John Skiles. There has been no development of this deposit. Ash Grove Cement West conducted surface-sampling projects on its claims in 1984 and 1986-1987.

This exposure of the Nelson Marble trends N. 80° E. and is about 5,000 ft long and 1,200 ft wide. About three-quarters of the exposure is east of Powell Creek along the top and slopes of a small east-trending ridge. Bedding trends in the limestone range from due west to N. 65° W. Most dips are to the south in excess of 50°. The rocks are foliated roughly parallel to bedding.

The limestone is crystalline and ranges from medium to light gray. Very little chert was observed. Results of sampling by Ash Grove in 1984 are given in Table 15. The samples represent 100-ft intervals along two lines across the eastern and western parts of the deposit, respectively. Samples AVB-86 and -87 (Table 1) are the analytical results of two samples from the north slope of the exposure.

A large amount of high-quality limestone suitable for sugar rock and cement is indicated. Ash Grove does not intend to mine this deposit for many years unless conditions change. The deposit adds to its already substantial reserves at the Durkee quarry.

French Gulch deposits (locality F-8):

Location: Several small limestone masses are exposed in the slopes of Burnt River near the mouth of French Gulch in sec. 3, T. 12 S., R. 41 E. French Gulch 7½-minute quadrangle.

Owner: Most deposits are on USBLM land. No development.

Individually, the deposits range from a few tens of feet to several hundred feet wide and are separated by phyllite and other noncarbonate rocks. They are steeply foliated and appear to be structural blocks elongated parallel to the foliation. Samples AUB-91 through -93 (Table 1) are representative of parts of three different exposures along the Burnt River road.

Campbell Gulch (locality F-9):

Location: N½ sec. 12, T. 12 S., R. 41 E., about half a mile south of Burnt River between the 3,460- and 4,400-ft elevations.

Owner: USBLM land. No development.

The deposit is about half a mile long from east to west and up to 800 ft wide. It is exposed through about 800 ft of relief, and its north slope is quite steep. The body appears to be fault bounded on the south. Rock in the fault zone is silicified locally. Analytical results of a series of five chip samples (AUB-94 through -98) extending from north to south across

Table 15. *Analyses of samples from the Powell Creek deposit (locality F-7), Durkee-Fox Creek area. Samples were collected and analyzed by Ash Grove Cement West, Inc. All values are in weight percent.*

Sample length (ft)	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Na_2O	K_2O
East line								
300- 400	0.97	0.2	0.12	54.46	0.15	0.04	0.01	0.02
400- 500	0.66	0.11	0.00	54.5	0.21	0.03	0.01	0.01
500- 600	0.54	0.08	0.03	54.78	0.09	0.02	0.06	0.00
600- 700	0.81	0.19	0.00	53.06	2.05	0.03	0.04	0.02
700- 800	1.44	0.2	0.13	52.38	2.42	0.03	0.00	0.03
800- 900	0.41	0.09	0.00	54.49	0.52	0.03	0.00	0.00
900-1,000	0.46	0.09	0.00	54.79	0.36	0.02	0.04	0.01
1,000-1,100	0.4	0.05	0.00	55.15	0.1	0.02	0.01	0.00
1,100-1,200	1.01	0.08	0.03	54.77	0.12	0.02	0.05	0.01
1,200-1,300	0.23	0.07	0.00	55.18	0.12	0.02	0.03	0.00
1,300-1,400	0.24	0.05	0.00	55.14	0.07	0.02	0.00	0.00
1,400-1,500	0.12	0.06	0.00	54.7	0.65	0.02	0.04	0.00
1,500-1,600	0.82	0.04	0.11	47.31	8.76	0.04	0.02	0.00
1,600-1,700	21.1	0.07	0.49	42.11	1.74	0.05	0.00	0.07
West line								
200- 300	2.77	0.09	0.17	53.5	0.28	0.03	0.00	0.01
300- 400	1.94	0.05	0.00	53.87	0.22	0.03	0.02	0.00
400- 500	1.03	0.12	0.1	54.27	0.32	0.02	0.02	0.01
500- 600	1.25	0.13	0.00	51.01	3.87	0.03	0.01	0.00
600- 700	0.57	0.1	0.03	53.57	1.53	0.03	0.04	0.00
700- 800	0.58	0.08	0.00	54.12	0.94	0.02	0.06	0.00
800- 900	0.39	0.04	0.00	54.55	0.49	0.02	0.00	0.00

the western part of the exposure for about 500 ft are presented in Table 1. The limestone is foliated, gray, and coarsely crystalline. Locally, it contains chert and small masses of phyllitic rock.

Bald Mountain area (area G)

This area includes more than 25 small marble occurrences on the slopes of the divide between Burnt River and Powder River, mainly in the vicinity of Bald Mountain.

The following information is from in-progress mapping of the Dooley Mountain and Brannan Gulch 7½-minute quadrangles by James G. Evans (personal communication, 1988).

The marble occurrences are in the Burnt River Schist. They range from a few tens of feet to about 600 ft in longest dimension. All of the deposits are similar lithologically. They consist of blue-gray, fine-grained marble that is generally massive and locally foliated; in places, the marble has white, coarse-grained quartz veins up to 12 in. wide at the margins. One small body in the upper Cow Creek drainage is enclosed in talc. The marble is associated with blocks and lenses of meta-andesite and metadiorite, massive gray-green cherty sandstone, and chert-pebble-, shale-chip-, and limestone-bearing conglomerate. Evans interprets the deposits as slide blocks from a possible andesitic arc on which reef limestone was deposited.

No chemical analyses are available, but many of the deposits appear to be quite pure limestone. None of the deposits appears to be large enough for development in the foreseeable future.

Pleasant Valley-Virtue Hills area (area H)

This area includes more than 100 small limestone exposures in the grass-covered rolling hills north, east, and west of Pleasant Valley, which is about 13 mi southeast of Baker via Interstate I-84. The locations of many of the deposits shown in Figure 13 were furnished by Merlynd Nestell.

The deposits range from a few tens of feet to about 500 ft long. They tend to form low-lying outcrops that, because of their light-gray color and the sparse vegetation of the area, are distinguishable from a distance. At least two of the deposits have produced small amounts of limestone, presumably for local use. Remains of an old lime kiln are adjacent to U.S. Highway 30 near Pleasant Valley.

The limestones form small lenses and irregular masses in the Elkhorn Ridge Argillite. Few are over 200 ft long. The limestone typically is medium to coarsely crystalline and gray to dark gray, with veinlets and splotches of white calcite. Associated rocks are mostly argillite and chert, with local occurrences of greenschist and tuffaceous argillite. Many of the deposits contain high-quality limestone but are too small to be of commercial interest except for local use.

Nodine Creek and Lawrence Creek (locality H-1):

Location: Prostka (1967) shows several small deposits in the southern parts of T. 10 S., Rs. 43 and 44 E. Durkee 15-minute quadrangle. In T. 10 S., R. 44 E., deposits occur on both sides of the ridge between the head of Nodine Creek and the north fork of Daly Creek. The area is centered about 9 mi by road from Interstate I-84 at Durkee. The deposits in T. 10 S., R. 43 E., are in the Lawrence Creek drainage, a similar distance from Durkee.

Owner: Not determined. None of the deposits has been developed.

The associated rocks are argillite, greenschist, and chert. An exposure in the SE¼SE¼ sec. 22, T. 9 S., R. 44 E., is about 200 ft long and 50 ft wide. Part of the exposure protrudes as

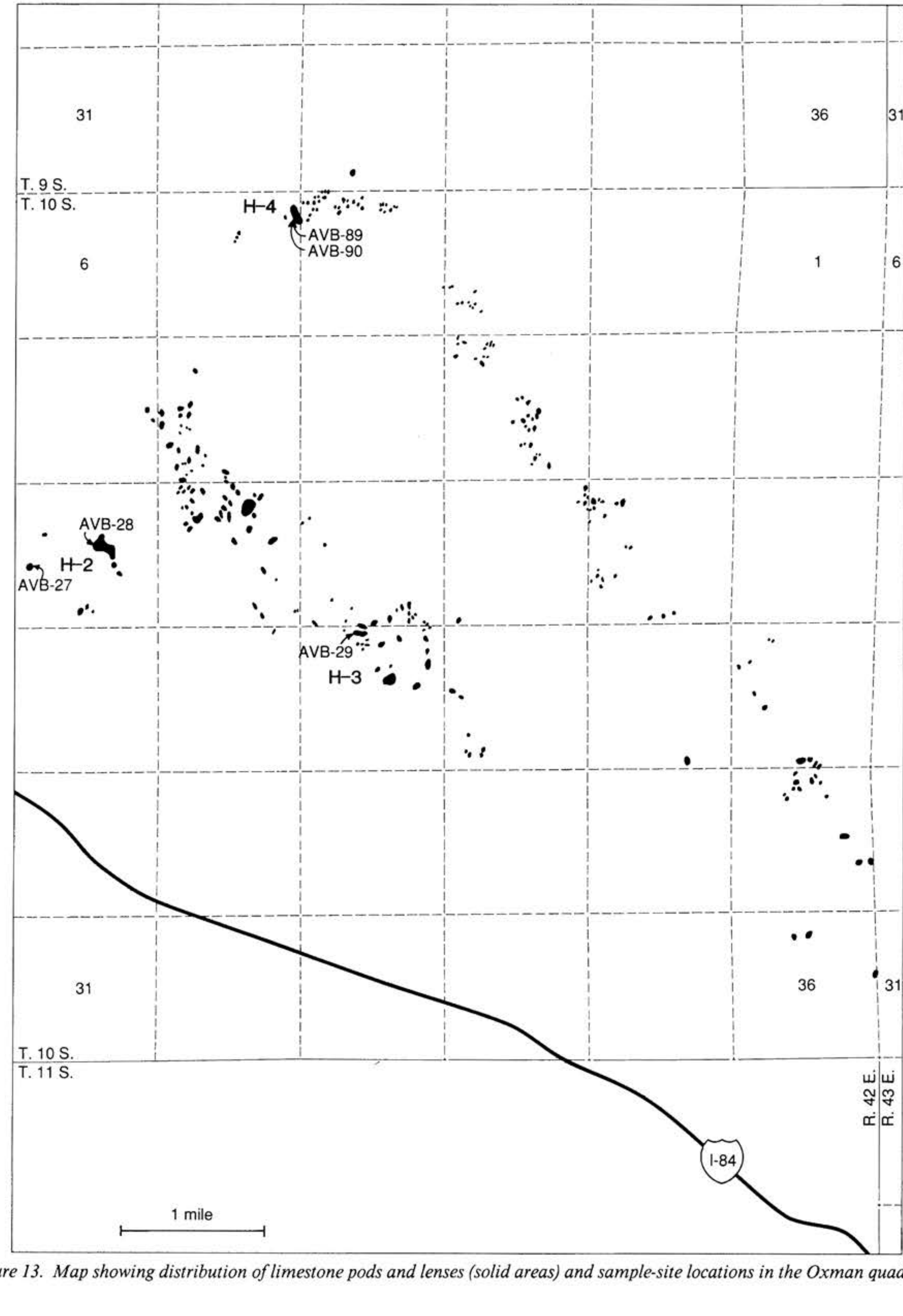

Figure 13. Map showing distribution of limestone pods and lenses (solid areas) and sample-site locations in the Oxman quadrangle.

much as 20 ft above ground level. Analysis of one sample (AVB-26) is given in Table 1.

Oxman 10 (locality H-2):

Location: One of the largest exposures is in the SW¼NE¼ sec. 18, T. 10 S., R. 42 E. Oxman 7½-minute quadrangle.

Owner: USBLM land.

The limestone exposure is about 500 ft in diameter. Float extends for several hundred feet east of the exposure. Some quarrying was done along the west edge of the deposit in the early days. Presumably the limestone was converted to lime in the kiln at Pleasant Valley. The excavation is a single bench cut about 170 ft long, 40 ft wide, and about 20 ft deep at the face. Probably about 5,000 tons of limestone were removed. Analysis of one sample (AVB-28) from the cut is given in Table 1.

Another, somewhat smaller, quarry is located about half a mile south also in sec. 18 in a limestone deposit about 150 ft across. Sample AVB-27 is from a deposit of similar size in the NW¼SW¼ of the same section.

Oxman 13 (locality H-3):

Location: Sec. 21, T. 10 S., R. 42 E., on the east side of Straw Ranch Creek. Oxman 7½-minute quadrangle.

Owner: USBLM land. No development.

Sample AVB-29 is from a deposit about 400 by 150 ft in area in the NE¼NW¼ of the section.

The deposit includes two bedded limestone sequences 40 ft and 20 ft thick that are separated by about 20 ft of bedded argillite and chert. This section dips about 35° W. A larger deposit in the SW¼NE¼ of the section is an isolated block 300 by 400 ft in area and about 20 ft thick. The attitude of bedding approximately parallels the slope.

Second Creek (locality H-4):

Location: NW¼NW¼ sec. 4 and NE¼NE¼ sec. 5, T. 10 S., R. 42 E., on a south-facing slope just above creek level. Oxman 7½-minute quadrangle.

Owner: Not determined. No development.

Limestone outcrops and float cover an area about 500 ft long and 200 ft wide. The limestone is gray and medium to finely crystalline. Two composite grab samples were taken, one (AVB-89) across the west side and the other (AVB-90) across the east side of the exposure. The results of analyses are given in Table 1. Figure 14 is a photo of the exposure from the south.

Figure 14. Second Creek deposit (locality H-4), with view to the north, Pleasant Valley-Virtue Hills area.

Elkhorn Ridge area (area I)

This area includes the mountainous country west of Baker valley known as Elkhorn Ridge. Distribution of limestone deposits is shown in Figure 15.

Two deposits, the Marble Creek and Baboon Creek quarries, have been productive. Both were operated by the Chemical Lime Company from 1957 to 1971. Development of the quarries commenced in 1957 and 1963, respectively. The limestone was used primarily to produce chemical-grade lime at a plant at the Wing siding adjacent to the Union Pacific Railroad and near U.S. Highway 30, 5 mi north of Baker.

Total combined sales from the Baboon Creek and Marble Creek quarries were 347,675 tons of lime valued at $7.354 million (U.S. Bureau of Mines records, Spokane, Washington). Several thousand tons of low-grade lime were dumped and remain near the plant site. In 1984-1985, Blue Mountain Lime Company screened and sold for agricultural use several hundred tons of crushed limestone that had been stockpiled near the Marble Creek quarry during the Chemical Lime Company operations.

Marble Creek quarry (locality I-1):

Location: Secs. 13 and 14, T. 9 S., R. 38 E., on the south side of Marble Creek on the east side of Elkhorn Ridge 12 mi west of Wing siding. Elkhorn Peak 7½-minute quadrangle.

Owner: Blue Mountain Lime Company.

The deposit consists of two blocks of crystalline limestone about 400 ft apart and enclosed in argillite and chert of the Elkhorn Ridge Argillite. Only the eastern block has been mined. Following is a description of the deposit from an unpublished report by Richards (1953), who was involved in the early exploration and development of the deposit.

> The eastern and more accessible lens covers an area of 450 by 350 ft and has a vertical exposed relief of 250 ft. Reserves of quarryable stone in this lens based on recent core drilling are estimated at 1.9 million tons. The western lens covers a larger surface area. While it has not been drilled, the extent of the outcrop indicates that it may represent 3 million tons of limestone. The apparent strike of these lenses is N. 50° E., and dip 70° SE. The limestone lacks bedding and banding. Typical specimens show it to be a uniform, gray-colored, fine-grained stone.

Only the eastern lens that Richards described has been developed.

Analyses of grab samples AVB-72 through -76 and -88 from various parts of the quarry are presented in Table 1.

The limestone in the quarry is cut by a large mafic dike that made obtaining a clean product somewhat difficult. For that reason, in 1963, this quarry was deactivated, and the Baboon Creek quarry was opened to provide limestone for the plant at Wing.

The western lens of the Marble Creek deposit is well exposed on a ridge above creek level and could be easily mined in benches. Analysis AVB-88 (Table 1) represents a chip sample of limestone from a dozer cut in the top of the exposure.

Baboon Creek quarry (locality I-2):

Location: The Baboon Creek deposit surrounds the common corner of secs. 16, 17, 20, and 21, T. 9 S., R. 38 E. Elkhorn Peak 7½-minute quadrangle. The deposit is about 3 mi by steep mountain road west of the Marble Creek quarry. Most of the product was trucked to the plant at Wing over a longer route of about 38 mi.

Owner: Blue Mountain Lime Company.

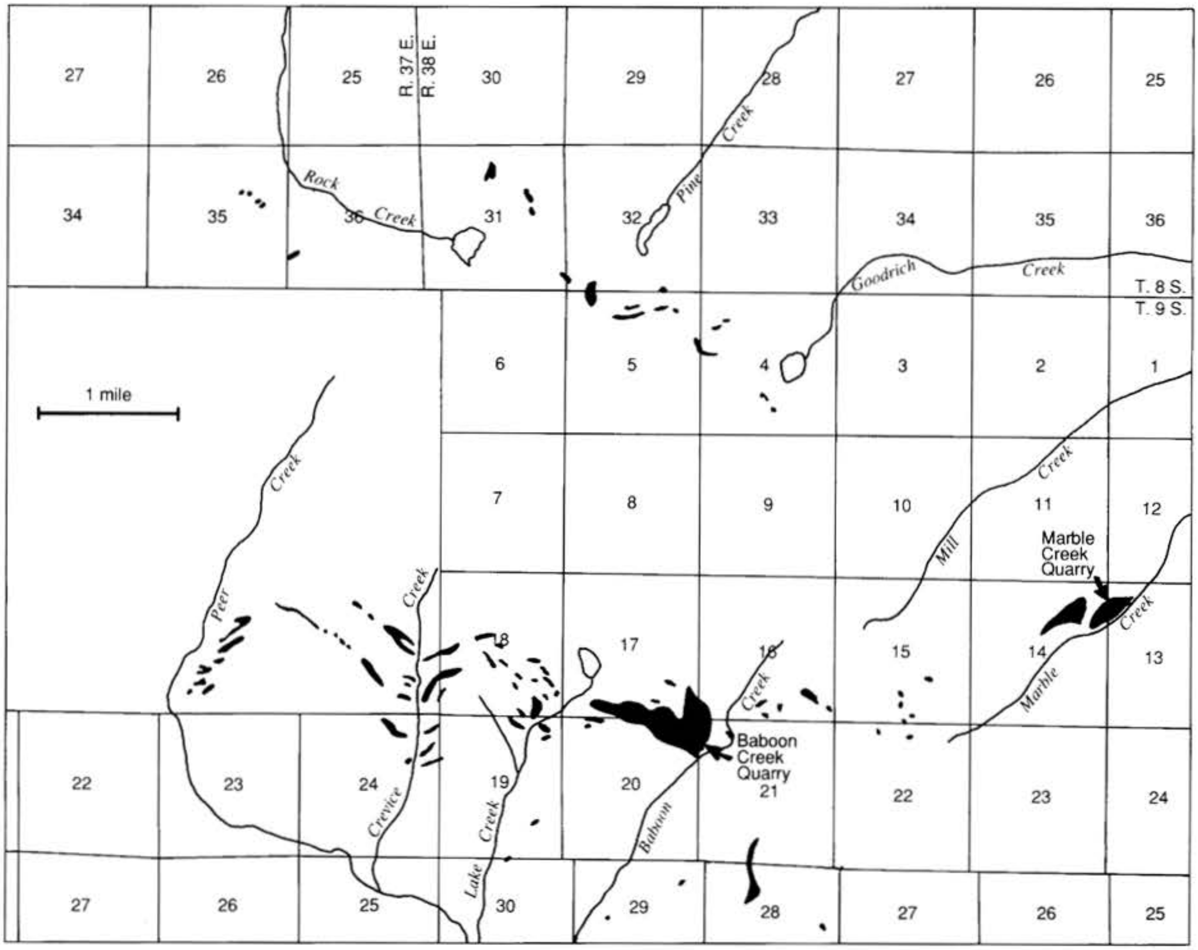

Figure 15. Map showing distribution of limestone deposits (solid areas) in part of the Elkhorn Ridge area (area I). Modified from maps of the Bourne and Elkhorn Peak quadrangles by Brooks and others (1982) and Ferns and others (1987), respectively.

The outcrop area is hook shaped, more than 4,000 ft long, and up to 1,200 ft wide. It extends from Baboon Creek westward to Lake Creek. The quarry lies between 6,000- and 6,500-ft elevation in the east end of the exposure adjacent to Baboon Creek. The quarry is one of two (see Marble Creek quarry) that were developed and operated by Chemical Lime Company during 1958-1971. The Baboon Creek quarry was activated in 1963 and operated until 1971, when the plant and quarries closed.

The associated rocks are mainly argillite and chert. Several small basalt dikes cut the limestone in the quarry walls. The marble is mostly massive and crystalline and ranges from dark gray to nearly white in color. Most of it, however, is medium gray. Chip samples AUB-168 through AUB-174 (Table 1) are representative of the limestone in the western part of the quarry.

According to Chemical Lime Company reports, reserves of metallurgical-grade limestone amount to about 16 million tons proven and 100 million tons probable.

Lake Creek (locality I-3):

Location: Secs. 17, 18, 19, and 20, T. 9 S., R. 38 E., and secs. 23 and 24, T. 9 S., R. 37 E., about 27 mi by road west of Baker. Elkhorn Peak and Bourne 7½-minute quadrangles.

Owner: USFS land. No development.

Several small limestone pods and lenses occur in the broad belt extending westerly across Lake, Crevice, and Deer Creeks. These deposits are in the western part of the belt that includes the Baboon Creek deposit. They are enclosed in chert and argillite of the Elkhorn Ridge Argillite.

The areas mapped as limestone by Ferns and others (1987) are actually composed of a number of small limestone bodies separated by argillite and chert, many no more than 200 ft long and 50 ft thick. One of the largest limestone bodies is in the southeast corner of sec. 18, T. 9 S., R. 38 E. It is about 800 ft long and 500 ft thick. The area is mostly covered by limestone float and has some limestone outcrops. Argillite and chert float are rare. The limestone is crystalline massive and ranges from gray to white in color. Some is mottled gray, light gray, or white. No bedding or foliation was observed. Samples AUB-165 and -166 are from this area.

In an area along the road up the east side of Crevice Creek in the SW¼ of sec. 18, limestone and chert are interbedded through a zone about 500 ft long. Most of the limestone is massive. It weathers light gray and is darker gray on fresh surfaces. One limestone lens about 180 ft thick is composed mostly of limestone breccia (limestone fragments in limestone matrix). Some of the fragments have a mudstone appearance. Sample AUB-167 is representative of this material.

Upper Pine Creek (locality I-4):
Location: Secs. 31 and 32, T. 8 S., R. 38 E., and secs. 4 and 5, T. 9 S., R. 38 E. Several deposits occur in the headwaters of Pine Creek in a belt about 3 mi long along the upper northeast flank of Elkhorn Ridge. Elkhorn Peak 7½-minute quadrangle.

Owner: USFS land. No development.

The deposits occur as small pods, lenses, and thin, discontinuous beds in the Elkhorn Ridge Argillite. Most of the deposits are located in the steep walls of glacial cirques and are inaccessible by road. Because of their remote location, none of the deposits is considered to have economic importance. The limestone is a coarsely recrystallized marble with a dark- to medium-gray color on fresh surface that weathers light gray. The deposits are badly deformed and contain lenses and interbeds of argillite and chert.

Bulger Hill (locality I-5):
Location: SW¼SE¼ sec. 9, T. 7 S., R. 38 E. The property is in the foothills of Elkhorn Ridge on the west side of Baker Valley. It is on the southeast flank of Antelope Peak, between the 4,400- and 4,800-ft elevations. Rock Creek 7½-minute quadrangle.

Owner: Not determined.

Several thin, discontinuous beds of crystalline limestone were observed in an area about 1,200 ft long and 300 ft thick trending N. 80° W. The limestones are interbedded with chert and argillite in an exposure of Elkhorn Ridge Argillite that is elongated to the northwest and that is about 1,000 ft wide near the limestone. The exposure is in contact with metadiorite on the northeast and is intruded by quartz diorite on the southwest.

The limestone bodies are near the quartz diorite contact. They range from 20 to 50 ft thick and from 150 to 600 ft long. The limestone is coarsely crystalline. It varies from gray to nearly white and locally is thinly banded. Some is iron stained. Bedding and foliation in the limestone and argillite are nearly parallel and strike approximately N. 80° W. and dip steeply north. Analysis of one grab sample (AVB-25) of the limestone appears in Table 1.

Taubeneck (in preparation) reported that garnet skarn can be traced along the contact of the marble with the quartz diorite for about 550 ft. Thin seams of scheelite up to 0.6 in. wide occur along the garnet-marble contact.

John Day area (area J)

Dog Creek (locality J-1):
Location: Central part of sec. 32, T. 13 S., R. 32 E., on the west side of Little Dog Creek between 3,700- and 4,000-ft elevation, 5 mi east and south of John Day. John Day 7½-minute quadrangle.

Owners: Most of the exposed limestone is on land owned by Denny Dahl. The northeasternmost exposures are on land owned by Bill Elliott. No development.

The largest limestone exposure occupies the crest and upper south slope of a small hill flanking Little Dog Creek on the west. Several smaller exposures occur on the north and east slopes of the hill. The limestone is associated with argillite and chert. Chert and limestone are interbedded along the southwest margin of the larger exposure. Bedding strikes east and dips about 50° N. Limestone beds vary from a few inches to about 4 ft thick. Chert beds vary from a few inches to about 1 ft thick. The hilltop exposure looks relatively pure, but the quantity available is so small that no mining is likely to occur.

The limestone is medium gray and medium to coarsely crystalline, with veinlets and clots of nearly white calcite. Analysis of one sample (AVB-23) composed of random chips from several parts of the largest exposure is given in Table 1.

Dayville-Antone area (area K)

This area includes several small limestone occurrences associated with exposures of metamorphosed, pre-Tertiary rocks in the vicinity of Spanish Gulch and Birch Creek southwest of Dayville. The area is about 5 mi southeast of Antone and 35 mi by road southwest of Dayville.

Dobell (1948) indicates that marble is exposed on the ridge between Spanish Gulch and Mule Gulch. Taubeneck (1950) mapped two small limestone lenses in sec. 18, T. 13 S., R. 27 E. Dawson (1951) described limestone occurrences on West Birch Creek, one reportedly in the SW¼SW¼SE¼SW¼ sec. 17, T. 13 S., R. 25 E., and another "about 300 yards N. 5° W. along the ridge." There is no record of limestone production from any of the deposits.

West Birch Creek (locality K-1):
Location: NW¼SW¼ sec. 17, T. 13 S., R. 25 E., 5.2 mi southeast of Antone near the top of the east-facing slope of West Birch Creek between 4,400- and 4,800-ft elevation. Antone and Day Basin 7½-minute quadrangles.

Owner: Undetermined. No development.

Access from Antone is across part of the Antone Ranch. The deposit is near the ranch boundary with federal land. The limestone deposit is associated with a pre-Cretaceous assemblage of weakly metamorphosed rocks, including argillite, graywacke, quartzite, andesite, and serpentinized ultramafic rocks.

The limestone exposure is estimated to be about 200 ft long and up to 80 ft wide. The limestone is crystalline, medium to dark gray, and cut by many closely spaced white calcite veinlets (paper thin to a quarter of an inch thick) oriented in all directions. Small amounts of chert were seen in a few places but were not enough to greatly affect the overall grade of the deposit. Sample AVB-24 (Table 1) represents chips from various parts of the exposure. Although much of the limestone appears to be of good quality for cement and other uses, it does not appear large enough or close enough to market to be considered of significant future value.

A search for the limestone occurrences that Dawson (1951) described was unsuccessful.

Olds Ferry terrane deposits

The Olds Ferry terrane adjoins the Baker terrane on the south and includes the southeasternmost exposures of pre-Tertiary rocks in the Blue Mountains.

The Olds Ferry terrane is composed of the Huntington and Weatherby Formations of Late Triassic and Early and Middle Jurassic age, respectively. Most of the terrane is underlain by rocks of the Weatherby Formation. Exposures of the Huntington Formation are confined to the southeastern part of the terrane, mainly along the Snake River. The Huntington Formation is made up mainly of Late Triassic volcanic and volcaniclastic rocks of island-arc origin. The Weatherby Formation is composed mainly of clastic sedimentary strata, chiefly volcanic wacke and siltstone, of

Early and Middle Jurassic age. The Jett Creek Member at the base of the Weatherby Formation is characterized by a distinctively red- and green-colored conglomerate. Limestone deposits of importance in the terrane are in the Jett Creek Member, although small deposits a few tens of feet thick are locally interlayered with volcanic wacke and siltstone stratigraphically higher in the Weatherby Formation. Deposits at Lime have produced more than 9 million tons of limestone, most of which was used in the manufacture of cement. An undeveloped deposit of large tonnage potential is located at Juniper Mountain. Limestone is a very minor constituent of the Huntington Formation. The largest deposits are a few tens of feet thick and a few hundred feet long. Most contain thin interlayers of volcaniclastic rocks. None of these deposits is further described herein.

Lime area (area L)

Lime quarries (locality L-1):

Location: Secs. 25, 26, 27, and 34, T. 13 S., R. 44 E., adjacent to Interstate I-84 and the Union Pacific Railroad 40 mi southeast of Baker. Huntington 15-minute quadrangle.

Owner: Ash Grove Cement West, Inc.

The property consists of 1,064 acres and is divided by I-84 and Burnt River. The cement plant is adjacent to the freeway on the east side. Limestone has been produced from a quarry on the north flank of the ridge west of the freeway and three quarries in Marble Creek canyon east of the freeway. Figure 16 is an air photo of the area.

Limestone was mined and burned to make lime at this location in the 1880's. In 1916, the Acme Cement Plaster Company built a mill at Lime where they added sand and cow hair to the burnt lime to produce a plaster material.

A portland cement plant was completed and placed in operation in November 1923 by Sun Portland Cement Company, which was incorporated that year under the leadership of R.P. Butchart of Victoria, British Columbia. Concurrently, Butchart was an official of the Oregon Portland Cement Company, which had an operating cement plant in Lake Oswego and quarries near Dallas and Roseburg. The two companies were merged in 1926 under the latter name.

Initial capacity of the plant at Lime was 94,000 tons of cement per year. This was increased to 225,000 tons per year in 1956 by adding a second kiln. The plant was closed in November 1979, when the Durkee plant began operating. It was restarted for a short time in 1980. Since that time, the production facilities have been closed.

Cement output of the plant at Lime during its 58 years of operation (1923-1980) totals about 6.2 million tons. Annual production figures are given in Table 16. The quarries at Lime produced more than 9 million tons of limestone. Of this amount, 4,442,360 tons were used in cement manufacture at Lime, 4,033,741 tons were shipped to the company's plant in Lake Oswego, and 548,069 tons were shipped for use in sugar factories. Most of the limestone shipped to Lake Oswego was used in making cement. Some of it was sold for use in agriculture and other purposes.

Initial development was the Limerock quarry on the west side of Burnt River. It was operated through 1955. Development of the quarries in Marble Creek canyon on the east side of Burnt River began in late 1945 and continued through 1968, although the 1963-1968 production was limited. The 1968-1977 production of 196,000 tons was screened, low-grade material from a slide area in Marble Creek canyon near the plant. A conveyor belt line about 4,500 ft long was installed in 1953 and until 1963 was used to carry limestone to the plant from the quarries in upper Marble Creek. The Marble Creek quarries produced about 4.4 million tons of limestone. By 1963, the quarries had become expensive to operate, and from then on, the bulk of the limestone used in producing cement at Lime was trucked from the Durkee quarry. Since mining ceased, the walls of the larger quarries in Marble Creek canyon have collapsed, and the working floors are covered by landslides.

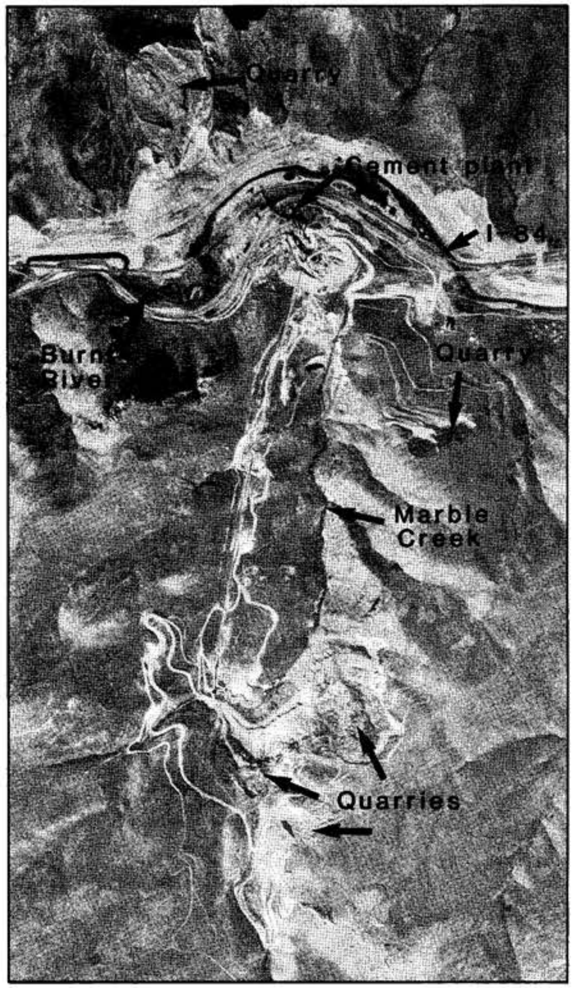

Figure 16. Air photo (1969) of Lime area (area L), in secs. 23, 26, and 35, T. 13 S., R. 44 E., showing the cement plant and quarries operated by Oregon Portland Cement Company. Production from the quarries dwindled sharply after 1963 and ended about 1968. Cement production ceased in 1980.

Oregon Portland Cement Company was purchased by Ash Grove Cement Company in 1983, and the name was changed to Ash Grove Cement West, Inc.

The limestone is part of the Jett Creek Member of the Weatherby Formation of Early and Middle Jurassic Age. The Jett Creek Member is about 800 ft thick and is characterized by red and green pebble and cobble conglomerate, grit, and sandstone and siltstone; also included are massive and thin-bedded limestone, calcareous siltstone, arkosic sandstone, and minor gypsum and anhydrite. Fossil ammonites indicate

Table 16. *Production of the cement plant and quarries at Lime from 1923 to 1979 by the Oregon Portland Cement Company. Data from Oregon Portland Cement Company and U.S. Bureau of Mines records.*

Year	Tons cement sold	Limestone used and shipped			
		Used at lime	Shiped to Lake Oswego	Sugar rock	Total
1923	775	10,187	--	--	10,187
1924	54,024	74,353	--	--	74,353
1925	68,503	90,453	--	--	90,455
1926	66,581	105,174	--	--	105,174
1927	45,382	60,851	--	--	60,851
1928	43,689	65,094	--	--	65,094
1929	45,898	53,588	--	--	53,588
1930	60,589	92,365	--	--	92,365
1931	81,190	76,822	--	--	76,822
1932	27,252	44,900	--	--	44,900
1933	12,342	19,877	--	--	18,977
1934	29,676	46,983	--	--	46,983
1935	63,104	74,787	9,513	--	84,300
1936	48,807	62,684	41,548	--	104,232
1937	47,087	70,670	35,339	--	100,009
1938	38,576	51,867	27,850	19,879	99,596
1939	46,186	60,090	36,022	28,950	125,062
1940	42,454	57,069	59,195	20,057	136,320
1941	87,145	100,864	70,155	18,314	189,028
1942	90,576	116,354	81,413	30,390	228,158
1943	83,729	111,413	76,826	23,575	211,814
1944	49,449	71,813	96,270	18,221	186,304
1945	70,988	93,466	102,510	29,580	225,556
1946	79,847	103,426	129,345	38,409	271,181
1947	80,243	93,500	159,583	55,823	309,505
1948	79,399	95,045	215,762	45,036	356,863
1949	74,676	101,133	219,973	39,344	360,454
1950	76,639	104,211	234,728	65,972	404,912
1951	96,446	132,014	240,183	34,340	406,536
1952	88,886	129,413	207,490	49,329	386,231
1953	84,783	129,775	261,069	30,850	421,694
1954	101,380	130,323	262,567	--	392,890
1955	91,215	134,179	167,723	--	301,903
1956	99,626	144,255	270,703	--	414,959
1957	134,541	186,613	254,323	--	440,936
1958	202,198	285,826	328,473	--	614,299
1959	132,907	195,081	280,502	--	475,583
1960	219,623	303,642	88,974	--	392,615
1961	120,425	168,624	41,852	--	210,476
1962	107,718	145,915	33,850	--	179,765
1963	191,951	22,215	--	--	22,215
1964	118,718	15,342	--	--	15,342
1965	140,935	16,945	--	--	16,945
1966	246,649	--	--	--	--
1967	157,114	--	--	--	--
1968	174,663	20,787	--	--	20,787
1969	142,451	24,163	--	--	24,163
1970	143,713	--	--	--	--
1971	154,362	9,769	--	--	9,769
1972	196,425	8,658	--	--	8,658
1973	217,069	35,513	--	--	35,513
1974	206,451	36,419	--	--	36,419
1975	186,606	27,279	--	--	27,279
1976	218,225	22,687	--	--	22,687
1977	198,813	6,484	--	--	6,484
1978	244,388	1,400	--	--	1,400
1979	234,819	--	--	--	--
Totals	6,247,906	4,442,360	4,033,741	548,069	9,018,591

Early Jurassic (early Sinemurian to late Pliensbachian) age. The unit rests unconformably on Upper Triassic volcanic rocks of the Huntington Formation about 2 mi south of Lime. The limestone unit at Lime is irregular in shape, about 3 mi long, and up to a mile wide. It consists of interbedded calcareous siltstone, siltstone, limestone, and dolomitic limestone. Only small, scattered deposits were found to be large enough and pure enough for use in making cement.

Analytical results of seven samples (AVB-65 through -71) from several different places in and near the walls of the upper quarries in Marble Creek canyon are given in Table 1.

Cavanaugh Creek (locality L-2):

Location: Secs. 3 and 10, T. 14 S., R. 44 E., about 0.7 mi west of I-84 and 3 mi northwest of Huntington. Huntington 15-minute quadrangle.

Owner: Not determined. There has been no development.

The deposit consists of two prominently exposed blocks of gray, massive to locally thin-bedded limestone.

The larger exposure is cut by Cavanaugh Creek and is about 1,000 ft long parallel to the creek and 500 ft wide. The smaller exposure is about 300 ft to the south. It is less than 500 ft in diameter. The deposit is about 2.3 mi southwest of Lime. It was sampled by Oregon Portland Cement Company as a possible source of limestone for the cement plant there. Analyses of six samples from various parts of the larger exposure averaged 98.40 percent $CaCO_3$ and 1.56 percent $MgCO_3$.

The deposit is a block within the Jett Creek Member of the Weatherby Formation and is assumed to be about the same age as the deposit at Lime.

Limestone Butte (locality L-3):

Location: Secs. 19 and 30, T. 14 S., R. 44 E., in sage-covered hills about 4 air mi west-southwest of Huntington in southeastern Baker County. Huntington 15-minute quadrangle.

Owner: Not determined. No development.

Thinly bedded, light-gray limestone is interlayered with conglomerate, sandstone, and siltstone of the Jett Creek Member of the Weatherby Formation.

Limestone outcrops are discontinuous over an area of about 1 mi^2. Limestone occupies less than a third of that area. Bedding dips gently west and southwest. Distribution of outcrops indicates that, in most places, the limestone is less than 10 ft thick. The thickest exposed section is about 40 ft underlying Limestone Butte. Some of the small limestone exposures on the northeast slope of the butte may be slide blocks. Samples AUB-33 through AUB-37 (Table 1) are from various parts of the deposit.

Phipps Creek (locality L-4):

Location: Sec. 34, T. 14 S., R. 43 E., and secs. 2 and 3, T. 15 S., R. 43 E., about 9 air mi southwest of Huntington. Huntington 15-minute quadrangle.

Owner: Not determined. No development.

Brooks (1979a) shows three separate limestone exposures. One is cut by Phipps Creek. The other two are about 300 yd to the northeast and 700 yd to the southeast, respectively.

These limestones are part of the Jett Creek Member of the Weatherby Formation and are associated with conglomerate, sandstone, siltstone, and calcareous siltstone.

The deposits consist of gray, massive and thin-bedded limestone and calcareous siltstone. Because of the interbedded siltstone, the overall grade of the deposits appears to be too low for most limestone uses, and the amount available is too small to warrant development. No analyses are available.

Juniper Mountain area (area M)

Location: Secs. 9 and 10, T. 16 S., R. 41 E., on the northeast slope of Cottonwood Mountain roughly 8 mi by gravel and dirt roads from paved U.S. Highway 26. Brogan 15-minute quadrangle.

Owner: Private land owned by Bernard Ingle. There has been no development.

The limestone-bearing area is over a mile long and 1,000 to 1,500 ft across (Figure 17). The limestone varies from thin-bedded to massive. Observed beds range from less than an inch to 15 ft in thickness. Locally, some beds appear laminated. Most of the limestone is medium gray in color. Some, however, is dark gray, and some is color banded parallel to bedding.

The limestone-bearing unit is poorly exposed. Limestone outcrops cover less than 20 percent of the area and typically are widely spaced and irregularly distributed. The larger outcrops range up to 20 ft wide, 20 ft high, and 100 ft long and

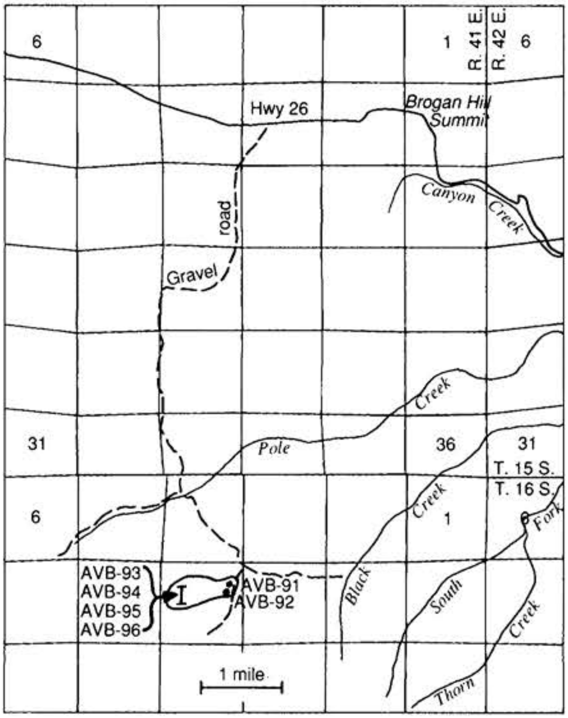

Figure 17. Map showing location of Juniper Mountain limestone deposit (area M) and sample locations.

usually involve massive beds. Most areas between limestone outcrops contain only limestone float and soil, suggesting that these areas are underlain by limestone. However, some could be underlain in part by clastic sedimentary rocks that do not resist erosion well enough to produce megascopic fragments in the soil. Only drilling or excavation will tell.

Strike of bedding in the western part of the area ranges from W. (southern part) to N. 60° E. (middle) to N. 50° W. (northern). Dips range from 60° N. to vertical. Locations of six samples (AVB-91 through -96) are shown on Figure 17. Analyses are given in Table 1.

Izee terrane deposits

The Izee terrane consists of the Upper Triassic to Upper Jurassic sequence southwest of John Day. The major components of the succession are clastic sedimentary strata, predominantly turbidites of volcanic derivation but including volcanic flows, tuffs, and conglomerates. The sequence has an aggregate thickness of about 50,000 ft and has been divided into a number of different formations and members (Dickinson and Vigrass, 1965).

Izee-Suplee area (area N)

The Izee-Suplee area is centered about 40 mi southwest of John Day and includes the pioneer settlements of Izee and Suplee in the western part of Grant County. A paved county road extends through the central part of the area connecting with U.S. 395 at a point 18 mi south of John Day and with U.S. 26 at Prineville. Most of the limestone deposits are accessible by gravel or dirt ranch and logging roads branching from this highway.

Limestone deposits in the area are associated with other sedimentary rocks in the Begg, Brisbois, Graylock, Robertson, Suplee, and Weberg Members of the Snowshoe Formation.

The Weberg Member is composed of sandy limestone and calcareous sandstone. Dickinson and Vigrass (1965, p. 94) described a part of the type section of the member in SW¼ and SE¼ sec. 19, T. 18 S., R. 26 E., which included 90 ft of "dominantly gray-brown silty to fine sandy limestone with intercalated layers of calcareous shale; weathers to yellowish buff or rusty yellow chips and blocks."

Ingle Rock (locality N-1):

Location: Includes occurrences in SW¼NW¼ sec. 9, T. 15 S., R. 30 E., along the ridge extending south from Ingle Rock between the forks of Percival Creek. Mount Vernon 15-minute quadrangle.

Owner: Not determined. The deposit is undeveloped.

Limestone breccia deposits at Ingle Rock and northeast of there were mapped by Brown and Thayer (1966) as a local basal facies of the Murderers Creek Graywacke. They describe the exposures as "lenses as much as 1,500 ft long and 120 ft thick as at Ingle Rock. Subangular blocks and cobbles range from 2 in. to a foot; a few blocks are as large as 20 ft in maximum dimension. The matrix is calcareous silt studded by well-rounded pebbles of chert, quartz, mudstone, and volcanic rocks." Conglomerate limestone deposits of a similar nature are exposed on the east side of the broad divide between the upper forks of Percival Creek in the W½NW¼ sec. 9, T. 15 S., R. 30 E., at an elevation of about 5,500 to 5,800 ft. A poor road up the right fork of Percival Creek ends at a small spring. The limestone is exposed on the slope above the spring. Although the area is heavily timbered, outcrops of the limestone are abundant in the small area that was visited.

The limestone is generally massive but closely jointed locally. Bedding features are rare. Exposures are commonly rounded. The limestone rock is medium gray to dark gray and is made up of rounded to subangular fragments of limestone and silicic rocks (quartzite, siliceous siltstone, quartz, chert, and felsic volcanics) in a calcareous matrix. The limestone fragments range up to 5 in. across. The silicic rock fragments range up to 2 in. across. The grade ranges from pure limestone to about 40 percent noncarbonate rock in most outcrops. Probably the overall rock content in most outcrops is 10-15 percent. Analyses of three samples (AUB-39 through -41) of typical limestone from different parts of the deposit are given in Table 1.

Stewart Spring (locality N-2):

Location: Secs. 29 and 32, T. 15 S., R. 29 E., near Stewart Spring. Izee 15-minute quadrangle. Access is via the road up Wickiup Creek and past the Roba-Westfall Mine and the head of Dans Creek.

Owner: USFS land. No development.

Limestone occurs as fragments in breccia lenses in the lower part of the Murderers Creek Graywacke. Part of the following information is from Brown and Thayer (1977). The limestone typically occurs as subangular blocks 2 in. to a foot across; a few are as large as 20 ft in maximum dimension. The matrix is calcareous silt studded with well-rounded pebbles of chert, quartz, mudstone, and volcanic rocks. Two exposures adjacent to the road and about a quarter mile apart each appear to be about 100 ft long and 10 to 20 ft thick. The carbonate weathers light gray and is dark gray on fresh surface. Analyses of two samples (AUB-49 and -50) of the limestone, one from each of the two exposures, are given in Table 1.

Cow Creek (locality N-3):

Location: Secs. 8 and 17, T. 17 S., R. 27 E., near the confluence of Cow Creek with Pine Creek. Some exposures are visible from the highway. Funny Butte 7½-minute quadrangle.

Owner: Not determined. No development.

The limestone is part of the Robertson Formation. Dickinson and Vigrass (1965, p. 93) described a section of the formation measuring 220 ft thick and including four limestone layers from 3 to 25 ft thick separated by volcanic sandstone and mudstone layers 15 to 75 ft thick at this locality. The limestones and some sandstone beds are highly fossiliferous locally.

Analyses of two samples (AUB-42 and -43) of the thickest (25-ft) limestone bed in the section are shown in Table 1.

Pine Creek (locality N-4):

Location: W½ sec. 9, T. 17 S., R. 27 E., about 0.7 mi west of the South Fork of the John Day River on the south side of the highway. Izee 15-minute quadrangle.

Owner: Not determined. No development.

The limestone is exposed as a series of ribs as much as 30 ft high and 20 to 100 ft apart. They strike roughly N. 30° E. and dip 55° to the south. The exposed area is about 500 ft across on a steep, south-facing slope adjacent to the highway.

The limestone weathers grayish brown and is dark gray on fresh surfaces. Rounded to subangular, sand- to pebble-size rock fragments comprise up to 20 percent of the limestone. No clastic interbeds were observed.

The limestone is part of the Brisbois Formation of Late Triassic age of Dickinson and Vigrass (1965). They describe the main part of the formation as black, gray, and green mudstone with intercalated sandy calcarenite, calcareous sandstone, and tuff. A volcanic member is exposed locally. The sandy calcarenite is gray and weathers gray or brown. The calcareous sandstone beds are gray and weather tan or brown. Analyses of three samples (AUB-46 through -48 in Table 1) are of samples collected from different parts of the exposure and are believed to be representative of the exposed limestone.

Harris Spring exposure (locality N-5):

Location: SE¼SW¼ sec. 26, T. 17 S., R. 26 E. Funny Butte 7½-minute quadrangle.

Owner: Not determined. No development.

Dickinson and Vigrass (1965) describe a section 335 ft thick of the Mowich Group containing five limestone horizons ranging from 3 to 20 ft thick and totaling 56 ft. Analyses AUB-44 and -45 represent samples of two of the thicker limestone units. The limestone is light gray to pale brown and is interbedded with sandstone.

Grindstone terrane deposits

The Grindstone terrane adjoins the Izee terrane on the west and includes the southwesternmost exposures of pre-Cenozoic rocks in the Blue Mountains. The area is centered about 25 mi southeast of Paulina and includes parts of Crook and Harney Counties. Graveled and dirt access roads extend southeast from the Crooked River Highway (paved) at Suplee and at a point 10.2 mi east of Paulina. The deposits are in hilly terrain and mostly on private ranch land. Elevations range from about 4,500 to 5,500 ft.

Rocks of the terrane are poorly exposed. Most outcrops are small, isolated blocks of limestone or, more rarely, silicic volcanic rocks, chert, conglomerate, or sandstone. Limestones of Devonian, Mississippian, Permian, and Jurassic age are included. Despite the dearth of exposures, Merriam and Berthiaume (1943) defined the Coffee (Mississippian), Spotted Ridge (Pennsylvanian), and Coyote Butte Formations and included most of the terrane in one or another of these units. Age assignments were based on fossils found in scattered limestone exposures. Later workers have determined that the exposed rocks are not stratigraphically continuous and may represent tectonic blocks in a melange (Dickinson and Thayer, 1978) or an olistostrome (Blome and Nestell, in preparation). Part of the following information is from the latter report.

Grindstone-Twelvemile area (area O)

Most of the limestone blocks in the Grindstone terrane occur in a belt about 2 mi wide and 11 mi long trending N. 20° E. across the upper parts of Twelvemile, Grindstone, and Trout Creeks in Tps. 17, 18, and 19 S., Rs. 24 and 25 E. (Figure 18). Figure 19 illustrates the character of limestone outcrops in sec. 29, T. 18 S., R. 25 E. A majority of them are elongated parallel to the trend of the belt. Rock fragments in the soil indicate that areas between outcrops are underlain largely by volcaniclastic graywacke, siltstone, chert, argillite, and tuff. Well-rounded clasts of pebble to cobble size are common, showing the widespread occurrence of conglomerates in the sequence. Aerial photographs reveal systematic patterns of closely spaced, northerly striking lineations across parts of the limestone-bearing area that probably represent bedding. The limestone deposits tend to occur in strings that approximately parallel the photo lineation and are elongated parallel to the lineation.

Most of the limestone blocks are of Permian age and were assigned to the Coyote Butte Formation by Merriam and Berthiaume (1943). The oldest rocks are two small, widely separated blocks of cherty limestone of Middle Devonian age and associated chert, chert grit, and sandstone. The Coffee Creek Formation includes small exposures of impure gray limestone and calcareous sandstone of Late Mississippian age in the west-central part of the terrane.

Limestone of the Coyote Butte Formation is typically fine grained, massive, light gray to yellowish gray, and fossiliferous. Chert and volcaniclastic debris are abundant locally. The largest exposures are the Three Buttes and Tuckers Butte deposits. Smaller exposures occur in the central and northern parts of the terrane on the tops and flanks of topographic highs. Some of the limestone blocks in the central part of the terrane are dolomitic. Bedding within the limestone blocks generally dips steeply.

Chert replacement of limestone is common throughout the terrane and occurs as gray to black, translucent irregular patches, roundish to angular blocks, and pinch-and-swell layers that cut across or alternate with thicker limestone beds.

Grindstone 155 (locality O-1):

Location: NE¼ sec. 3 and NW¼ sec. 4, T. 18 S., R. 25 E., on the west-facing slope of the North Fork of Trout Creek. Suplee 15-minute quadrangle.

Owner: Not determined. No development.

The area contains more than a dozen limestone blocks ranging up to 350 ft long and 200 ft wide. The limestone is layered to massive and gray to brownish gray in color. Chert is abundant locally in most of the exposures. Analysis AVB-36 (Table 1) represents a chip sample from an outcrop about 300 ft long and up to 100 ft wide.

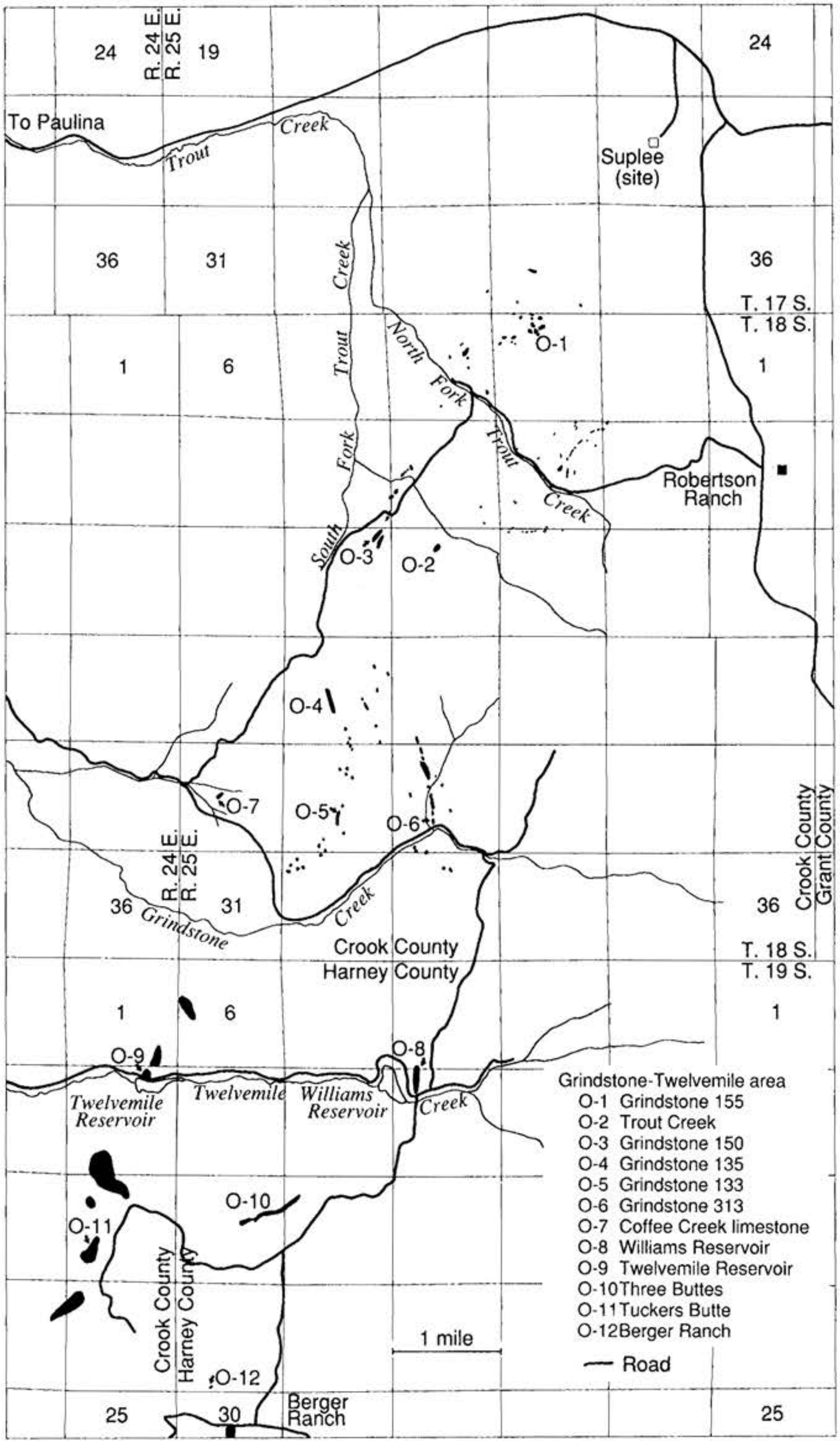

Figure 18. Map showing distribution of limestone deposits (solid areas) and property numbers in the Grindstone terrane (area O), Crook and Harney Counties.

Figure 19. Limestone outcrops in sec. 29, T. 18 S., R. 25 E., Grindstone-Twelvemile area (area O).

Trout Creek (locality O-2):
Location: NE¼NW¼ sec. 16, T. 18 S., R. 25 E. Suplee 7½-minute quadrangle.
Owner: Not determined. No development.
The deposit forms a small knob about 400 ft long and up to 300 ft wide near the north end of a north-trending ridge on the south side of the South Fork of Trout Creek. The limestone is largely crystalline. Colors range from medium to light gray and light brownish gray. Light-colored calcite veinlets are abundant. Most of the limestone is massive. Bedding in a small area on the northwest side of the exposure strikes N. 10° E. and dips 70°-80° W. Replacement chert is a minor constituent except in one small area where layers as much as 2 in. thick compose up to 10 percent of the rock.
Fossils in the limestone were identified as Devonian by Kleweno and Jeffords (1961).

Grindstone 150 (locality O-3):
Location: NE¼NE¼ sec. 17, T. 18 S., R. 25 E. Suplee 7½-minute quadrangle.
Owner: Grindstone Livestock Company. There has been no development.
The limestone exposure is about 200 ft wide and 500 ft long on a gentle northwest slope. Two or three smaller exposures occur less than 200 ft to the east. In the northern part of the deposit, the limestone is bedded and quite cherty. Bedding parallels the length of the deposit and dips nearly vertically. In the southern two-thirds of the deposit, the limestone is more massive and appears to contain little chert. Fossil debris is locally abundant. Sample AVB-33 is from the northern part of the deposit, and sample AVB-35 is from the southern part.

Grindstone 135 (locality O-4):
Location: NE¼SW¼ sec. 20, T. 18 S., R. 25 E. Delintment Lake 15-minute quadrangle.
Owner: Grindstone Livestock Company. There has been no development.
The deposit here is very similar to those at Grindstone 133 described below. Analytical results of one sample (AVB-31) are given in Table 1.

Grindstone 133 (locality O-5):
Location: NW¼SE¼ sec. 29, T. 18 S., R. 25 E., 5,080-ft elevation. Delintment Lake 15-minute quadrangle.
Owner: Grindstone Livestock Company. There has been no development.
Four small pods about 100 ft apart are aligned about N. 10° E. along the west edge of the ridge top. The largest pod is about 60 ft wide and 200 ft long. The others are less than half as large. The orientation of the pods suggests that their thickness is probably less than their width. Layered chert is exposed about 50 ft east of the south end of the larger pod. It is pale gray and recrystallized. Bedding in the chert strikes N. 70° E. and dips 80° N. Colors vary from pale gray to pale brown and pale yellow. The limestone is made up largely of partly recrystallized fossil, mainly crinoidal, debris with a somewhat sugary texture. In the northernmost pod, the limestone contains up to 50 percent sand and pebbles composed largely of chert.

Grindstone 313 (locality O-6):
Location: A string of small limestone exposures extends northward for nearly a mile in the western part of sec. 28, T. 18 S., R. 25 E. Delintment Lake 15-minute quadrangle.
Owner: Grindstone Limestone Company. There has been no development.
The exposures may represent a single, gently dipping bed or sequence that appears in most places to be only a few tens of feet thick. Chert is abundant locally. Sample AVB-101 is from an exposure on the east side of a shallow draw about 400 ft north of Grindstone Creek. Sample AVB-113 is from another of the series of exposures about 900 ft farther north.

Coffee Creek limestone (locality O-7):
Location: SE¼NW¼ sec. 30, T. 18 S., R. 25 E., near the head of a north tributary of Grindstone Creek at about the 4,900-ft elevation in Crook County, half a mile north of Spike Butte. Twelvemile Reservoir 7½-minute quadrangle.
Owner: Grindstone Livestock Company. There has been no development.
The deposit includes a prominent exposure of fossiliferous limestone about 120 ft long and up to 50 ft thick. Bedding strikes N. 30° E. and dips 50° to 70° W. The limestone is bordered on the west by a sequence at least 400 ft thick of interbedded calcareous sandstone and thin limestone beds and on the east by about 200 ft of dark-colored calcareous sandstone. The limestone is dark gray, fine textured, and cut by white calcite veinlets.
Merriam and Berthiaume (1943) assigned a Late Mississippian age to the limestone, based on both megascopic and microscopic fossils.

Williams Reservoir (locality O-8):
Location: SW¼ sec. 4 and NW¼ sec. 9, T. 19 S., R. 25 E., on the east side of Williams Reservoir on Twelvemile Creek about 4,820-ft elevation. Delintment Lake 15-minute quadrangle.
Owner: Grindstone Livestock Company. There has been no development.
The deposit includes a north-trending exposure of dark-gray limestone that is about a third of a mile long and varies in width from about 60 ft at the south end to about 150 ft near the north end. The exposure belt marks the crest of a low ridge. Distribution of float indicates the limestone unit may attain widths of up to 300 ft or more.
The limestone is thin bedded, fine grained, oolitic, and appears to be nonfossiliferous. White calcite veinlets are common. The bedding strikes north, paralleling the exposure, and dips about 70° east. Analyses AVB-100 and -112 (Table 1) represent chip samples taken across the southern and northern parts of the limestone exposure, respectively. The southernmost part of the exposure is bordered conformably(?) on the east by a sequence of buff-colored,

locally calcareous siltstone and shale with thin limestone interbeds containing fossils of Jurassic age (Ralph Imlay, via C.H. Blome, personal communication, 1986).

Twelvemile Reservoir (locality O-9):

Location: SE¼ sec. 1 and NE¼ sec. 12, T. 19 S., R. 24 E. Twelvemile Reservoir 7½-minute quadrangle.

Owner: Grindstone Livestock Company. There has been no development.

A string of small limestone exposures extends northeasterly for about 1,500 ft from the north edge of Twelvemile Reservoir. The limestone is interlayered and mixed with nonclastic rocks and chert. Sample AVB-99 is from the exposure nearest the reservoir. About 2,000 ft farther to the northeast, limestone and interlayered chert are exposed on the east side of a small knob.

Three Buttes (locality O-10):

Location: Secs. 17 and 18, T. 19 S., R. 25 E., in Harney County, about 5,300-ft elevation. Twelvemile Reservoir 7½-minute quadrangle.

Owner: Grindstone Livestock Company. There has been no development.

A limestone exposure about 3,500 ft long and up to 250 ft wide occupies the upper northern flank of a small but prominent ridge known as Three Buttes. This promontory was called Coyote Butte on earlier maps and is the type locality of the Coyote Butte Limestone (Merriam and Berthiaume, 1943).

The limestone strikes northeast, paralleling the trend of the exposure, and dips north at about 45°. The lower part of the section is massive, light-gray limestone containing fossil crinoid debris and fusulinid fauna. The upper part is finer grained, darker gray argillaceous limestone that contains brachiopod remains. Analyses AUB-110 and -111 (Table 1) are of chip samples from the western part of the exposure.

Tuckers Butte (locality O-11):

Location: Secs. 12, 13, 23, and 24, T. 19 S., R. 24 E. Twelvemile Reservoir 7½-minute quadrangle.

Owner: Grindstone Livestock Company.

Limestone is exposed on parts of three small northerly aligned buttes, which are unnamed on the Twelvemile Reservoir 7-minute quadrangle map. The middle butte is known locally as Tuckers Butte. Figure 20 indicates the location of exposures on each of the buttes. The limestone on the west slope of the northern butte is interbedded with silicic sedimentary and tuffaceous rocks. The carbonate beds range from a few inches to more than 3 ft thick and contain chert as layers up to a foot thick and nodules up to a foot across. In places, chert and limestone are interlayered. Because the noncarbonate sedimentary rocks are poorly exposed, the relative proportion of limestone to noncarbonate beds cannot be determined without excavation or drilling. Limestone bedding strikes about N. 10° W. and dips gently east.

Bedding on the middle butte strikes N. 45° W. and dips 25° W. The limestone perched on the top and north slope of the butte appears to be about 50 ft thick. Locations of samples are shown on Figure 20.

Berger Ranch (locality O-12):

Location: SE¼SW¼ sec. 19, T. 19 S., R. 25 E., about 2,300 ft northwest of the old Berger Ranch on a low ridge on the north side of Black Snag Creek. Elevation 4,592 ft. Twelvemile Reservoir 7½-minute quadrangle.

Owner: Grindstone Livestock Company. There has been no development.

The occurrence includes two prominent exposures about 90 ft apart; one about 120 ft by 50 ft, the other about 40 ft by 20 ft in area. The limestone is largely massive and gray, with white streaks and blotches. Enclosing rocks are not exposed. The limestone is of Devonian age (Kleweno and Jeffords, 1962).

Isolated deposits and lacustrine limestone and travertine deposits in eastern Oregon (area P)

Durkee travertine (locality P-1):

Location: Sec. 11, T. 12 S., R. 43 E. The deposit is centered half a mile south of the Ash Grove Cement West, Inc., cement plant and about 1,000 ft west of Interstate I-84 and Union Pacific Railroad. Durkee 15-minute quadrangle.

Owner: Ash Grove Cement West, Inc., and partners. No development.

The deposit consists of surficial travertine and calcareous tufa. Deposition occurred in the conduit and around the mouth of a hot spring.

Wagner (unpublished report, DOGAMI Baker Field Office, 1964) mapped six exposures of travertine and a number of slide blocks in an area about 1,200 ft across. The largest exposure is about 800 by 450 ft. The other exposures are much smaller. All are separated by soil and small outcrops of other rocks. Pre-travertine bedrock in the area includes phyllites, greenschist and small pods of marble of the Burnt River Schist and Nelson Marble, and a small outcrop of basaltic rocks, probably of Miocene age.

Wagner estimated the outcrop area of travertine at about 290,000 ft^2 and, assuming an average depth of 10 ft for the deposit and a weight of 148 lb per ft^3, the total amount of travertine present at 214,600 tons. Because no drilling or test pitting has been done, the dimensions of the deposits are unknown, particularly their depth.

The surficial character of the deposits indicates that they are fairly young, but some erosion of the deposit and deepening of the channel of Burnt River has occurred since the deposits were formed, and the deposits are not all the same age. There is no recognizable carbonate deposition at the present time, and only very small seeps are found in the vicinity of the deposits. Analyses of two samples (AVB-83 and -84) of the travertine are given in Table 1.

Shell Rock Butte (locality P-2):

Location: NW¼ sec. 14, T. 21 S., R. 44 E., near the Vale-Mitchell Butte road junction and about a mile west of Shell Rock Butte. Grassy Mountain and Double Mountain 7½-minute quadrangles.

Owner: USBLM land.

A massive bed of light-gray limestone as much as 5 ft thick occurs at the top of a sequence of interbedded light-gray calcareous lacustrine sandstone and siltstone in the Chalk Butte formation of Corcoran and others (1962). Sample AVB-80 is from a small hill in the NW¼ sec. 14, T. 21 S., R. 44 E., west of Shell Rock Butte. The limestone is porous and locally contains abundant fresh-water gastropod fossils. The base of the limestone is marked by large hemispheric stromatolite-like masses that appear to be algal structures.

Similar limestone deposits occur in the NE¼ sec. 35, and N½ sec. 36, T. 20 S., R. 44 E., and N½ sec. 31, T. 20 S., R. 44 E. The deposits are unconformably overlain by a fluviatile sequence of chert pebble conglomerate and sandstone (Ferns and Ramp, in preparation). Sample AVB-80 (Table 1) is representative of a large part of the deposit.

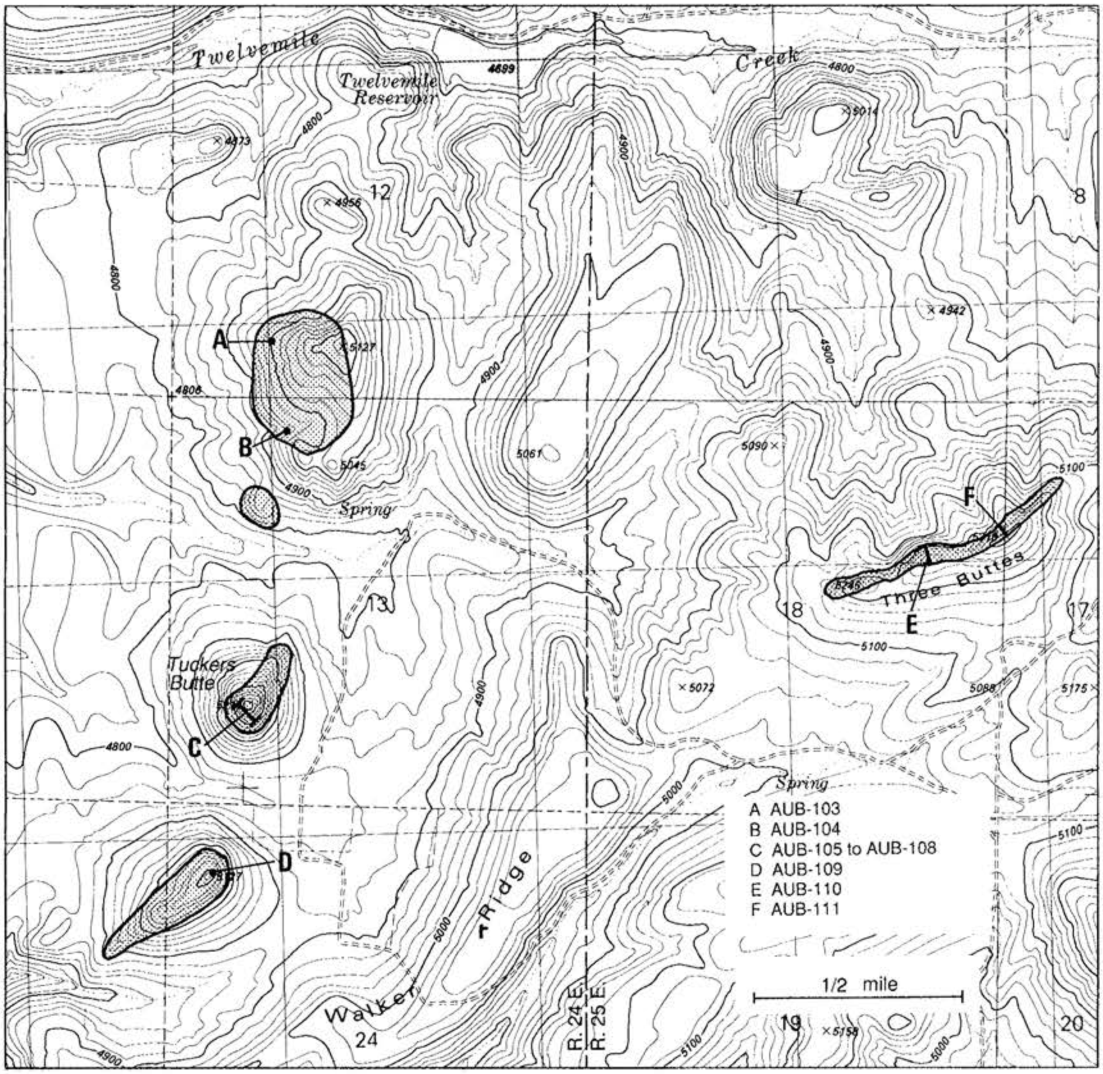

Figure 20. Sketch map of Three Buttes (locality O-10) and Tuckers Butte (locality O-11) limestone deposits (patterned areas) and sample sites.

Hay Creek Ranch (locality P-3):

Location: SW¼ sec. 25, T. 11 S., R. 15 E., on the Hay Creek Ranch about 2½ mi up Calivan Creek from Brewer Reservoir. Brewer Reservoir 7½-minute quadrangle.

Owner: Hay Creek Ranch. No development.

Thin limestone beds are widely separated in a thick, slightly metamorphosed turbidite sequence consisting mainly of siltstone and sandstone and lesser chert pebble conglomerate. A limestone bed up to 2 ft thick and about 50 ft long is exposed on the hillside above Calivan Creek road opposite a small cabin. Limestone float indicates that two or three other beds of similar thickness are interbedded with clastic rocks to the east in a zone about 150 ft wide. The limestone is dark gray, crystalline, fractured, and contains chert and clastic rock fragments. Wareham (1986) described the geology of the area and reported the occurrence of fossils of early and middle Eocene age in one of the limestone beds.

Tenmile Ridge (locality P-4):

This area includes the low-grade fresh-water carbonate deposits along the east margin of Summer Lake valley north of Paisley (Figure 21). It is in the Tenmile Ridge Wilderness Study Area, which is well known for an abundance of sand dunes.

N.S. Wagner (unpublished report, DOGAMI Baker Field Office, 1945) investigated the Tenmile Ridge claims in 1947 during a short-lived attempt by the owners to market some of the material. Wagner indicates that, in addition to deposits described here, lacustrine carbonate deposits also occur in secs. 12, 14, and 16, T. 32 S., R. 18 E.

The deposits visited are near the eastern margin of Summer Lake valley. They appear to lap against and therefore may be younger than the ridge-forming basalts east of the valley. Most of the valley floor west of the exposures is covered with playa deposits and sand. Drilling or other excava-

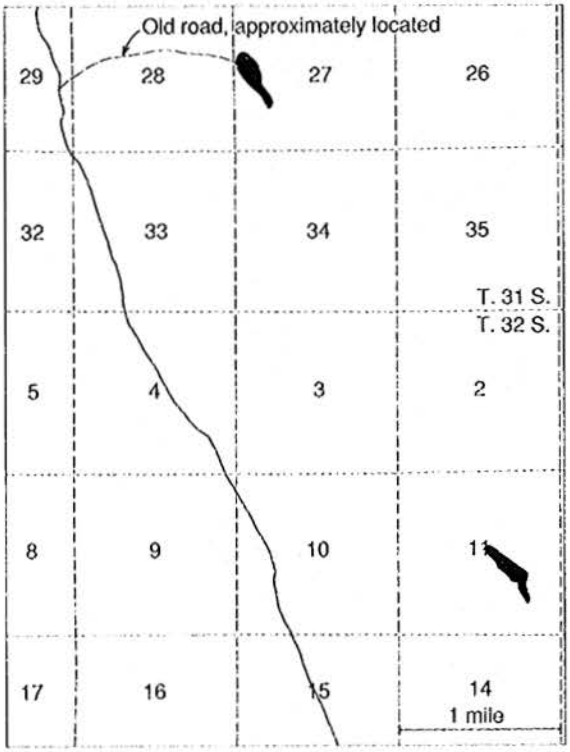

Figure 21. Map showing location of lacustrine limestone deposits (solid areas) north of Paisley in the Tenmile Ridge area (locality P-4).

tion would be needed to determine whether the carbonate deposits extend westward beneath the valley floor. The deposits are of late Tertiary age and consist of light-colored bedded lacustrine carbonate sequences, including coquina, calcarenite, sandy and silty limestone, and calcareous conglomerate. Fossil shells are abundant in some beds, but the exact age of their deposition has not been determined. Total thickness of beds exposed in the two areas visited is estimated at about 60 ft.

Chemical analyses show the magnesium to calcium ratio of the carbonate is high but variable. X-ray diffraction analysis indicates that the carbonate mineral in sample AVB-100 is dolomite. Presumably, sample AVB-103 contains a mix of calcite and dolomite. The strontium content of the samples ranges from 1,120 to 2,000 parts per million.

The deposits are too low in calcium carbonate content for most uses of limestone. Some potential uses may include chicken grit and agricultural limestone.

Tenmile Ridge claims:

Location: SW¼ sec. 27, T. 31 S., R. 18 E., about 13 mi north of Paisley by one-lane desert road. Loco Lake 7½-minute quadrangle.

Owner: USBLM land.

Development consists of a few shallow bulldozer trenches and pits dug mostly in the late 1940's by Ross Small, Delbert Baker, and others who investigated the deposit with the idea of marketing the material for agricultural purposes. There is no record of production or of further development. The road to the deposit north of Tenmile Ridge is nearly obliterated by erosion.

Fresh-water carbonate beds are well exposed on the east wall of a shallow gulley in an area about 2,000 ft long and 600 ft wide (Figure 22). The west side of the gulley is underlain by interlayered tuffaceous lake beds and mafic volcanic rocks. The carbonate section includes sandy and silty limestone; calcareous sandstone, siltstone, and conglomerate; and beds of coquina. Colors range from white to light brown. The conglomerate and coquina beds are most abundant near the bottom of the section. The upper part of the section is mostly sandy and silty limestone.

The coquina is made up mainly of consolidated fresh-water shell fragments, largely gastropod and clam shells. Fragments of pelloidal limestone also are common.

The carbonate section is about 60 ft thick. Individual beds range from a few inches to 5 ft in thickness. Strike of the bedding varies. Dips are less than 10° in most places. Basalt is exposed beneath the carbonate section near the south end of the carbonate exposure. Flow layering in the basalt is roughly conformable with bedding in the carbonate section.

The broad, gently sloping area between the carbonate exposure and the basalt exposures to the east is covered with sand composed partly of carbonate, which suggests that the slope is underlain by the carbonate sequence.

Chemical analyses of samples collected by Wagner in 1947 from the Tenmile Ridge claims are given in Table 17. Samples AVB-99 through -101 and AVB-105 (Table 1) are from different parts of sec. 27.

Sec. 11 deposits:

Location: East-central part of sec. 11, T. 32 S., R. 18 E., about 8½ mi north of Paisley via one-lane dirt road. Loco Lake 7½-minute quadrangle.

Owner: USBLM land. No development.

Exposed beds of the carbonate section have a total maximum thickness of about 60 ft. The lower 20 ft or so of the southern part of the exposure is mainly pebble and cobble conglomerate with carbonate matrix and some interlayered calcarenite. The upper part is mainly white- to buff-colored calcarenite that is hard enough to cause a hammer to ring when struck. Beds range from a few inches to 4 or 5 ft thick. Rock fragments are mostly basaltic. The conglomerate at the base of the exposed section consists, in part, of a jumble of disoriented blocks up to 10 ft or more across. The overlying beds dip about 6° to 8° W.

Here, as at the Tenmile Ridge claims, the sand-covered

Figure 22. Lacustrine limestone beds in the Tenmile Ridge area (locality P-4).

Table 17. *Analyses of limestone samples from the Tenmile Ridge claims north of Paisley. Samples were collected in 1947 by N.S. Wagner and analyzed by DOGAMI. All values are in weight percent.*

Sample no.	LOI	SiO_2	R_2O_3	CaO	MgO	P_2O_5	Soluble salts
HB-22-4	37.04	10.50	9.28	32.26	10.86	0.25	0.90
HB-19-1	15.30	39.34	21.02	13.10	5.20	0.24	2.87
HB-20-2	35.46	15.60	10.06	23.83	14.56	0.58	3.02
HB-21-3	41.50	5.50	5.12	28.79	19.26	0.11	0.74

slope east of the carbonate exposures probably is underlain by carbonate. Samples AVB-102, -103, and -104 (Table 1) are from the sec.-11 locality and are representative of the various types of carbonate rock.

SOUTHWESTERN OREGON, KLAMATH MOUNTAINS PROVINCE

Introduction

Most of the limestone occurrences in southwestern Oregon are in Josephine, Jackson, and Douglas Counties. Locations of deposits in Jackson and Josephine Counties discussed in this paper are shown in Figure 23.

The larger limestone operations have been the Marble Mountain quarry, which was last operated by Ideal Cement Company in 1967 in the Marble Mountain area of Josephine County, and a quarry operated by Oregon Portland Cement Company during 1915-1935 in the Roseburg area of Douglas County. Most of the production from these quarries was used for making cement. Some was used for agricultural purposes, paper manufacture, and other purposes.

There has been small production from a number of other deposits including the Muck quarry, Jones marble deposit, and Horsehead marble quarry in the Marble Mountain and Williams Creek area and the Lyons Gulch (Bristol limestone), Bristol dolomite deposit, Lively quarry, and the Baxter limestone deposit in the Gold Hill-Talent area.

All but one of the limestone deposits in southwestern Oregon are in the Klamath Mountains geomorphic province. Those in Jackson and Josephine Counties are in the Applegate Group, which Irwin (1966) includes in the Western Paleozoic and Triassic Belt. The deposits in Douglas County and one in northern Curry County are in the Otter Point Formation of the Sixes River terrane.

The Applegate Group (defined by Wells and others, 1949) consists of a great thickness, perhaps 40,000 ft or more, of metamorphosed marine volcanic and sedimentary rocks. The metavolcanic rocks include basaltic and andesitic flows, breccias, and tuffs. These rocks are typically greenish due to the presence of secondary chlorite, epidote, actinolite, and hornblende and hence commonly are referred to as "greenstones." Applegate Group metasediments include argillite, slaty siltstone, tuffaceous graywacke, minor conglomerate, chert, quartz mica schist, quartzite (usually metachert), and marble. The rocks are tightly folded. Prevailing strikes of bedding and foliation planes are about N. 30° E. but range from north-south to east-west. Dips are generally steep, mostly to the east. Rocks of the Applegate Group were intruded by and folded with serpentinites and peridotites and were later intruded by quartz diorite of Jurassic age. The Applegate Group was assigned to the Late Triassic by Wells and others (1949), based on fossils found by Diller and Kay (1909). Irwin (1966) suggests that Permian rocks may be present.

Descriptions of limestone-bearing areas and deposits

Gold Hill-Talent area (area Q)

This area includes several small limestone deposits and one dolomite deposit in the Rogue River drainage in the vicinity of Gold Hill, Rogue River, and Talent, including those on the slopes of Sardine, Kane, Galls, Foots, and Bear Creeks. The deposits are small, steeply dipping lenticular bodies usually no more than a few hundred feet long and 100 ft wide associated with volcanic and volcaniclastic rocks, argillite, and chert of the Applegate Group. The Bristol dolomite deposit is mostly dolomite and dolomitic limestone adjacent to the Bristol silica deposit. All of the other deposits for which analyses are available are low-magnesium limestone with few impurities. Typical analyses run between 88 and 97 percent $CaCO_3$. Most of the limestone is recrystallized and medium to light gray in color. Some is nearly white. Limestone from some of the deposits has been quarried and used for making cement at the cement plant at Gold Hill. Some has been used for agricultural purposes and for making paper.

A cement plant was located at the west edge of Gold Hill and operated between 1917 and 1967. The operation was somewhat sporadic in the early years. The plant was built in 1914 by Beaver Portland Cement Company and was operated by that company from 1917 to 1940, by Pacific Portland Cement Company from 1940 to 1952, and by Ideal Cement Company from 1952 to 1967. Initially, the plant used limestone from small deposits near the plant site (see section on Beaver Portland Cement Company deposits, below). After 1923, most of the limestone came from the Marble Mountain quarry 28 mi to the west. Some came from the Colvig Gulch deposit during World War II. Originally the plant had a rated capacity of 900 barrels of cement per day. This was increased to 2,000 barrels in the early 1940's. The plant had one kiln, which measured 11 ft by 241 ft, during its later years of operation. The plant has since been removed.

Beaver Portland Cement Company deposits (locality Q-1):
Location: NW¼ sec. 16, T. 36 S., R. 3 W., and SE¼ sec. 13, T. 36 S., R. 4 W. Gold Hill 7½-minute quadrangle.
Owner: Not determined.

The limestone from these deposits was used by Beaver Portland Cement Company during the early years of its operation of the cement plant at Gold Hill. Both appear to have been exhausted of cement-grade limestone. There is no record of the amount of limestone produced from this site.

Winchell (1914, p. 158) said the limestone in sec. 16 was 50 to 100 ft thick and at least 1,000 ft long, with a strike of N. 20° E. and dip of 65°to 80°E.

The quarry in sec. 16 also furnished shale for most of the cement made at the Gold Hill plant.

Rogue River (Rock Point limestone quarry) (locality Q-2):
Location: SE¼ sec. 23, T. 36 S., R. 4 W., between 1,400- and 1,900-ft elevation. Rogue River 7½-minute quadrangle.

Winchell (1914, p. 159) described a limestone deposit in this area as a lens about 100 ft thick striking N. 35° E. and dipping 70° E.

Dole limestone (locality Q-3):
Location: NW¼ sec. 13 and SW¼ sec. 12, T. 37 S., R. 4 W., on the west side of the Middle Fork of Foots Creek about

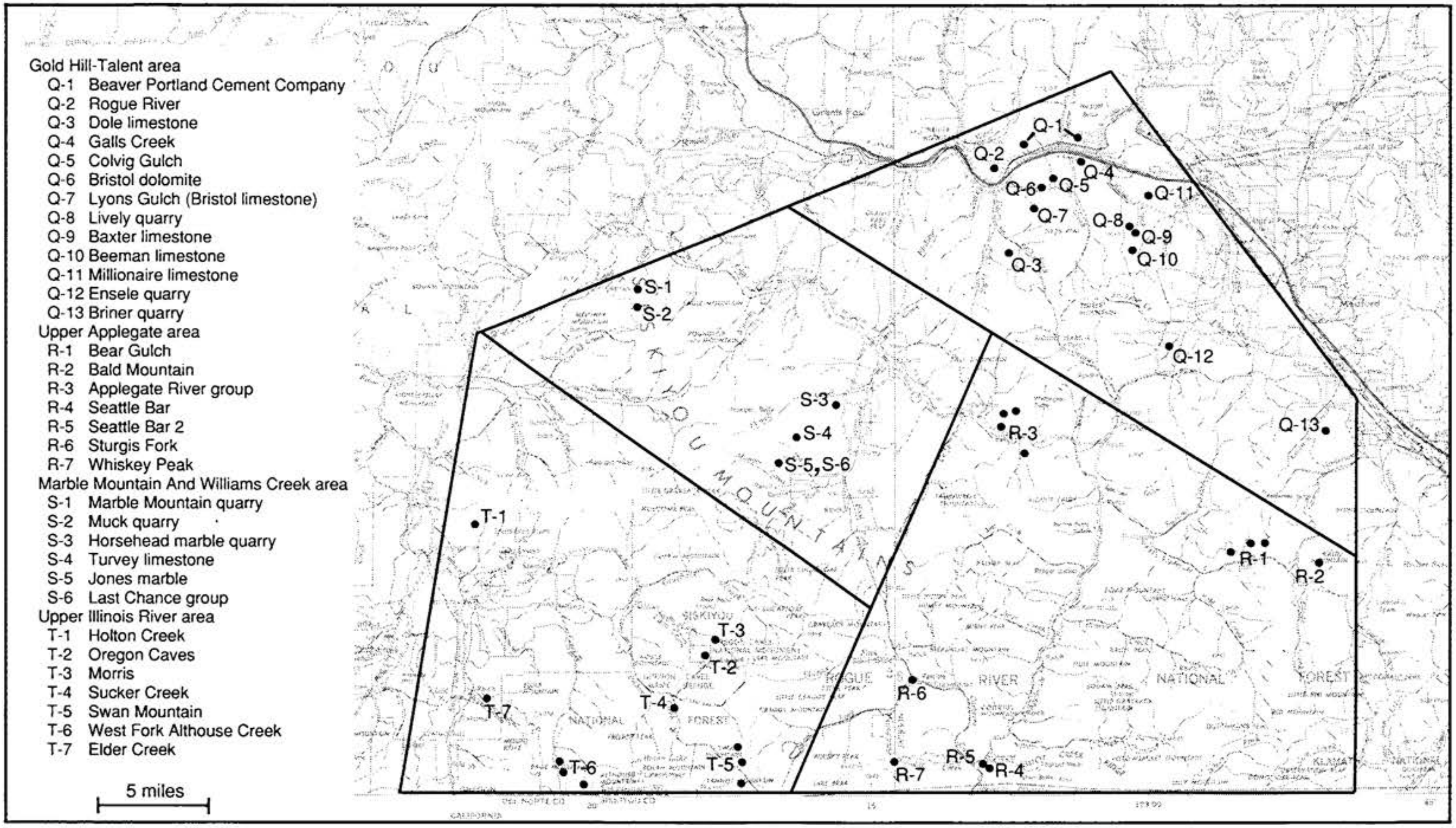

Figure 23. Map showing distribution of limestone occurrences in the Klamath Mountains.

10 mi from Gold Hill. Applegate 7½-minute quadrangle.

Owner: Private land owned by Edward Dole in 1958. No development.

The area is underlain by metamorphosed sedimentary and volcanic rocks of the Applegate Formation. The information following is condensed from Ramp (unpublished report, DOGAMI Grants Pass Field Office, 1958). Three small bodies of impure gray siliceous limestone are situated at about 2,075-ft elevation on the ridge near the section line between secs. 12 and 13, T. 37 S., R. 4 W. The area is quite brushy, and the size and relationships of the limestones are poorly known. The exposures range from 8 ft to 40 ft wide and 250 to 300 ft long. They are separated by argillite layers 10 to 15 ft wide. The western exposure strikes north and dips 80° E. A composite chip sample across the three limestone bodies assayed 70.4 percent $CaCO_3$. A sample of another exposure of limestone located about 1,000 ft to the southwest and measuring 18 ft by 45 ft assayed 31.05 percent $CaCO_3$. MgO was not determined.

Galls Creek (locality Q-4):

Location: Sec. 21, T. 36 S., R. 3 W. Gold Hill 7½-minute quadrangle.

Owner: Not determined. No development.

Winchell (1914, p. 158) reports that "on Galls Creek...at an elevation of 1,300 ft...limestone outcrops, but the extent is unknown....On the west side of Galls Creek near the south side of sec. 20 at an elevation of about 1,400 ft, a lens of limestone has a thickness of about 200 ft and a length of at least 500 ft. It strikes about N. 10° E. and dips about 85° E. To the southwest a few hundred feet, two more lenses of limestone are found parallel to the first and separated by quartzite."

Colvig Gulch (locality Q-5):

Location: NE¼NW¼ sec. 29, T. 36 S., R. 3 W., between 1,600- and 1,860-ft elevation near the top of the ridge east of Colvig Gulch. Gold Hill 7½-minute quadrangle.

Owner: Ideal Basic Industries owns the mineral rights. Dale Matheny owns the surface rights.

Development includes two small quarries and a short adit. John Ritter, a former long-time employee of Ideal Cement Company reported (personal communication, 1987) that limestone for the cement plant near Gold Hill was mined here for about two years during World War II. He described the deposit as consisting of two limestone lenses up to 75 ft wide and over 300 ft long. The lenses are separated by a zone of soft argillaceous rock about 50 ft wide. The limestone was good quality for cement, but obtaining a clean product was difficult due to the tendency of the argillaceous material to become mixed with the limestone during blasting and loading operations.

Bristol dolomite (locality Q-6):

Location: N½SE¼ sec. 30, T. 36 S., R. 3 W., on the north side of Millers Gulch about 6 mi by road (2½ mi by air) southwest of Gold Hill. Gold Hill 7½-minute quadrangle.

Owner: Bristol Silica and Limestone Company.

Dolomite occurs along the north margin of the Bristol silica quarry, which has been operated since about 1937.

Several million tons of silica rock have been removed from a quarry cut into a southwest-facing slope (Figure 24). Very little development of the dolomite has occurred. Possibly as much as 1,000 tons may have been mined from pits near the uppermost northern edge of the silica quarry. Nearly horizontal bulldozer cuts crosscut the dolomite in a few places for sampling purposes.

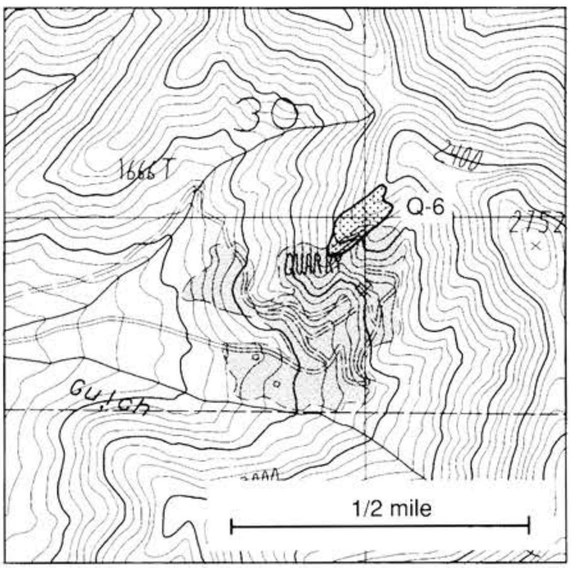

Figure 24. Map showing location of Bristol dolomite deposit (locality Q-6) adjacent to Bristol Silica quarry. Samples AUB-141 through -144, AUB-159, and AVB-40 through -42 are from various parts of the dolomite deposit.

Country rocks associated with the silica and dolomite bodies include altered volcanic rocks, argillites, and quartzites of the Applegate Group. The average trend of bedding and compositional layering is north to northeast, and dips vary from 45° SE. to nearly vertical.

Hotz (unpublished report, DOGAMI Grants Pass Field Office, 1942) described the silica deposit (Figure 25) as about 1,400 ft long, with an average width of 280 ft. The rock is finely crystalline, cream-colored quartz; some is bluish and translucent. The quartz may be of hydrothermal origin and may, in part, represent replacement of limestone.

Dolomite in contact with the silica rock is exposed along the upper north margin of the silica quarry. The northeast-trending dolomite exposure area is lens shaped, about 700 ft long, and up to 200 ft wide. Analyses of eight samples (AVB-40 through -42, AUB-141 to -144, and AUB-159) taken from various parts of the deposits are given in Table 1. Smaller lenses are exposed along the lower northwestern margin of the quarry. The dolomite is pale gray to white and medium to coarsely crystalline.

Along the contact, the silica and carbonate rocks are intimately mixed through a zone several feet thick. Small amounts of a white diopside occur in this transition zone, some of it coarsely crystalline.

Lyons Gulch (Bristol limestone) (locality Q-7):

Location: Two deposits occur about 1,300 ft apart on the east side of Lyons Gulch, one in the NW¼NW¼ sec. 6., T. 37 S., R. 3 W., and the other in the SW¼NW¼ sec. 6, T. 37 S., R. 3 W. Gold Hill 7½-minute quadrangle.

Owner: Not determined.

The north deposit is developed by a quarry about 90 ft across in both length and width; the face is about 30 ft high. The south deposit has been scratched a bit by bulldozer, and a few truckloads were removed.

Figure 25. Bristol Silica quarry. Dolomite adjoins the silica along the far upper margin of the quarry.

Libbey (1957) says that the quarry was opened in the mid-1940's by the Sullivan Lime Company to ship agricultural limestone to Willamette Valley farmers. A crushing plant was built on a railroad siding at Rogue River. The project barely got under way when the plant burned down.

The deposits are small and associated with argillite and graywacke of the Applegate Formation. A small faulted block of massive gray limestone is exposed in the northeastern part of the quarry. Analysis of a chip sample (AUB-157) taken horizontally across about 40 ft is given in Table 1. A much smaller block is exposed in the west wall of the pit, and a limestone bed about 2 ft thick is interbedded with argillite in the southeast corner. The latter sequence strikes N. 25° E. and dips nearly vertically. The deposit as exposed in the quarry walls is clearly faulted, and the limestone and argillite are intermixed to the extent that obtaining a clean product would require selective mining.

The south deposit is about 100 ft wide across the ridge. Bedding strikes north to northeast and dips steeply. Float indicates that some sedimentary layers are intercalated with the limestone. Sample AUB-158 (Table 1) represents chips from various parts of the exposure.

A cut at 1,900-ft elevation near the quarry exposes two limestone beds about 15 ft wide separated by about 110 ft of sedimentary rock. Trend of the west bed is N. 10° E., with a steep dip to the southeast.

Lively quarry (locality Q-8):

Location: NW¼SE¼ sec. 2, T. 37 S., R. 3 W., approximately 600 ft east of the Kane Creek Road at 1,840-ft elevation about 4 mi south of Gold Hill. Gold Hill 7½-minute quadrangle (Figure 26).

Owner: In part, USFS land.

Development includes a U-shaped open cut about 200 ft long by 60 ft wide at floor level and estimated 100 ft maximum depth. A tunnel about 200 ft long enters the west side of the cut at floor level. According to Hodge (1938), the tunnel connected the quarry with bunkers about 350 ft to the west adjacent to the Kane Creek road.

Early operators include the Lively Lime Company (Hodge, 1938). Apparently most of the quarry production was made prior to Hodge's visit and was shipped to Salem and Lebanon for use in paper manufacture.

Except for small scraps of limestone in the east and north walls of the quarry and outcrops that extend 30 or 40 ft north of the quarry, the deposit is largely exhausted above the quarry floor.

The bedding strikes N. 30° E. and dips 60° E. Limestone in the north end of the quarry is interlayered with argillite and metavolcanic rocks. Probably not over half of the material is limestone, and obtaining a clean product would be difficult. No information is available as to the amount of limestone that exists beneath the quarry floor. Samples AVB-43 and -44 (Table 1) are believed to be representative of the available limestone.

Baxter limestone (locality Q-9):

Location: S½SE¼ sec. 2, T. 37 S., R. 3 W., on the east side of Kane Creek about 4 mi south of the east Gold Hill exit off Interstate I-5 (Figure 26).

Owner: Bristol Silica and Limestone Company.

John A. Baxter located limestone deposits in the area in 1910 and later opened two small quarries 260 ft apart in elevation and both about 30 ft wide (Treasher, unpublished report, DOGAMI Grants Pass Field Office, 1943). Oregon Limestone Company shipped two carloads of paper rock in 1942.

Present development consists of a stripped area about 300 ft long and 200 ft wide located about 0.4 mi by road east of the Kane Creek road. Shallow cuts in the stripped area expose limestone in two places about 150 ft apart. The lower exposure is about 20 ft across. The upper exposure is at the southwest end of a limestone bed that is traceable uphill beyond the cut for about 600 ft to where it is crossed by a road cut at about 2,160-ft elevation.

The limestone bed, which is 15 to 30 ft thick (25 ft in the road cut), trends N. 35° E. and is nearly vertical. It is bordered by greenstone and metamorphosed sedimentary rocks, chiefly argillite and chert of the Applegate Formation. The limestone is crystalline and varies from white to dark gray. Thin, light- and dark-gray color banding is common. Analyses AVB-45 and AVB-106 (Table 1) represent chip samples across the bed in the stripped area and road cut, respectively.

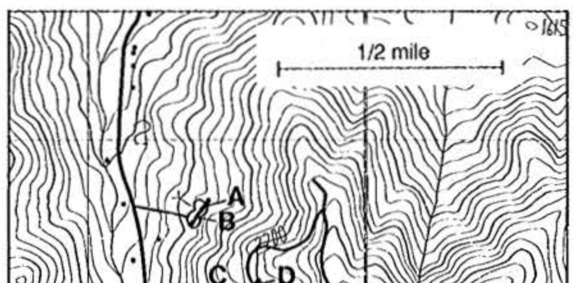

Figure 26. Map showing locations of the Lively quarry (locality Q-8), Baxter limestone deposit (locality Q-9), and sample sites, Gold Hill area.

Beeman limestone (locality Q-10):

Location: NE¼NE¼ sec. 11, T. 37 S., R. 3 W., about half a mile east of Kane Creek road and 6 mi south of Gold Hill. Mt. Isabelle 7½-minute quadrangle.

Owner: Not determined. Deposit is said to be on private land.

Parks and Swartley (1916, p. 8) mention limestone quarries near the Alice Gold Mine.

Treasher (Oregon Department of Geology and Mineral Industries, 1943b) reported that a quarry face about 70 ft long and 30 ft high was opened at the time of his visit in August 1941. There is no record of further development.

The deposit consists of small lenses of crystalline limestone interbedded with metasedimentary rocks of the Applegate Formation. Alternating light- and dark-gray color banding and cleavage in the limestone are parallel, strike N. 10° W., and dip steeply. Because the quarry face contains metasedimentary inclusions, the useable limestone represents only 15 to 20 ft of width.

Millionaire limestone (locality Q-11):

Location: SW¼SW¼ sec. 30, T. 36 S., R. 2 W., and E½SW¼ sec. 31, T. 36 S., R. 2 W., about 3½ mi by air southeast of Gold Hill. Sams Valley 7½-minute quadrangle.

Owner: Not determined.

According to Len Ramp (unpublished report, DOGAMI Grants Pass Field Office, 1988), the deposit in SW¼SW¼ sec. 30 is on a south-facing slope near the Millionaire Gold Mine, and the other is about a mile to the southeast; both are at about 1,600-ft elevation.

Both deposits consist of gray crystalline limestone associated with argillite and metachert. The one in sec. 30 is poorly exposed in partially caved-in, shallow trenches but appears to be 8 to 10 ft thick and about 150 ft long striking N. 10° E. and dipping steeply. An old stone shaft kiln, located a short distance downslope, apparently was used to produce lime from the deposit. The deposit in sec. 31 is less well exposed but may be a little larger. Small outcrops and boulders of marble are scattered over an area of about 150 ft by 200 ft.

Ensele quarry (locality Q-12):

Location: NW¼ sec. 6, T. 38 S., R. 2 W. Medford West 7½-minute quadrangle.

Owner: Not determined. No development.

The deposit is described by Winchell (1914, p. 142) as "a lens-shaped mass whose greatest dimensions correspond with the dip and strike of the argillite of the region. However, the deposit was so small that after an attempt to find it at greater depth by a crosscut adit had failed, the work stopped."

Briner quarry (locality Q-13):

Location: NE¼ sec. 29, T. 38 S., R. 1 W., 3.8 mi southwest of Phoenix. Talent 7½-minute quadrangle.

Owner: Not determined.

According to Hodge (1938), an old quarry exposes a limestone bed 20 ft wide and 50 ft long striking NE-SW and dipping 20° N. Discontinuous exposures can be traced northeastward to 2,800-ft elevation. He presented the following analysis and speculated that 28,000 tons of limestone might be present.

SiO_2	0.61
Al_2O_3	0.23
Fe_2O_3	0.23
CaO	55.44
MgO	0.34
Ignition loss	42.05
Total	98.88

The quarry had not been worked for 40 years prior to his visit, and at that time the stone was burned in a kiln adjacent to the quarry.

Upper Applegate area (area R)

This area includes a number of small limestone occurrences in the upper part of the Applegate River drainage in Jackson County. Most of the deposits have northeast-southwest strike, high-angle dip, and widths of 50 to 150 ft. They are associated with sedimentary and volcanic rocks of the Applegate Group. The deposits are situated 25 to 40 mi from a railroad.

Bear Gulch (locality R-1):

Location: Secs. 22, 23, and 24, T. 39 S., R. 2 W. Sterling Creek 7½-minute quadrangle.

Owner: The limestones in sec. 22, 23, and 24 are on Federal O&C lands but may extend onto private land along the river. No development.

Hodge (1938) described a series of northeast- to southwest-trending limestone lenses north of the Little Applegate River. They are exposed chiefly on the ridges on either side of Bear Gulch and in Muddy Gulch.

The limestone is dark gray and cut by numerous stringers of white calcite and a few of quartz from a quarter to 3 in. The lenses strike about N. 25° E. and dip about 45° NW. The limestone is usually interbedded in schists and shales, which weather rapidly, leaving the limestone as ridges. The limestone is somewhat banded and weathers to fairly smooth surfaces on the bedding planes. Each limestone bed usually contains small partings of schist.

The most persistent and best exposed deposit is in SW¼ sec. 23 on the ridge east of Bear Gulch between 2,700- and 2,950-ft elevation. It averages 65 ft in width, with one 5-ft schist parting near the footwall. The Sterling Ditch crosses the deposit and gives an excellent section.

Bald Mountain (locality R-2):

Location: Secs. 20 and 29, T. 39 S., R. 1 W., 6 mi southwest of Talent. Talent 7½-minute quadrangle.

Owner: USFS land. No development.

According to Mark Ferns (personal communication, 1988), gray crystalline limestone containing chert and argillite interbeds is exposed on the west side of the ridge extending north from Wagner Gap. The deposit is several hundred feet across, but its full extent is unknown.

Applegate River group (locality R-3):

Location: Secs. 23, 24, and 26, T. 38 S., R. 4 W., about 2 mi east of Applegate. Applegate 7½-minute quadrangle.

Owner: Not determined.

Wells (1940) shows eight individual occurrences with a northeasterly trend in this area. Peterson and Mason (1958) state that these occurrences are steeply dipping lenses of no great extent, with widths of 50 to 100 ft. An attempt to locate the deposits was unsuccessful.

Seattle Bar (locality R-4):

Location: NW¼SW¼ sec. 11, T. 41 S., R. 4 W., on the east side and above the Applegate River road about 33 mi from Medford or 45 mi from Grants Pass. The access road is paved to within 1 mi of the deposit. Carberry Creek 7½-minute quadrangle.

Owner: USFS land. No development.

F.L. Patterson and H.I. Kezer mined several hundred tons of marble from the deposit in 1961 in attempting to develop a combination granule, grit, and fertilizer business.

No further development has occurred. Part of the following is from an unpublished report by Ramp (DOGAMI Grants Pass Field Office, 1962).

The limestone forms a series of bold outcrops trending N. 30° E. and extending from the Applegate River to the north side of Manzanita Creek, a distance of about 0.7 mi. The best of the exposure extends from the Applegate River level to the top of the ridge between 2,000- and 2,640-ft elevation, a map distance of 1,000 ft.

The limestone is coarsely crystalline, grayish-white to white, and locally banded. Layers of quartz mica schist are included locally. The marble and enclosing schist strike from N. 25° to 45° E. and dip from 45° to 80° NW.

The marble stands in bold relief, forming cliffs as much as 45 ft above the more readily weathered metamorphic rocks. Composite thickness of the marble, including the interbedded schists, varies from about 60 ft on the ridge to about 140 ft at a point a third of the way up the hillside.

Analyses of the marble listed in Table 18 were performed by DOGAMI. Samples AUB-154 through -156 (Table 1) are representative of different parts of the deposit.

Table 18. *Analyses of limestone samples from the Seattle Bar deposit (locality R-4), upper Applegate area. All values are in weight percent.*

Assay no.	Sampler	$CaCo_3$	MgO	SiO_2	P_2O_5
P- 7244	H.D. Wolfe	96.99	--	1.11	0.079
P-25427	H.I. Kezer	98.92	0.20	0.26	--
P-25885	Ernest Gregg	98.68	--	0.40	--

Seattle Bar 2 (locality R-5):

Location: NE¼ sec. 10, T. 41 S., R. 4 W., about 0.4 mi west of Seattle Bar 1. Carberry Creek 7½-minute quadrangle.

Owner: Not determined. Development consists of a small open cut about 80 ft above the road.

This deposit was originally developed by Mexican Smelting and Refining Company to supply limestone for a matte copper smelter of the Blue Ledge Mine in northern California, about 5 mi to the south.

Recently, some of the marble was used as decorative stone at some recreation sites around the Applegate Reservoir. Total output has been a few thousand tons. A few hundred tons of broken rock remain on the pit floor.

The deposit consists of coarsely crystalline, white to light-gray marble. Some is banded white and gray. The marble contains an interbed of micaceous calcareous sedimentary rock 6 to 10 ft thick.

The deposit appears to be about 200 ft long and 50 ft wide and is enclosed mainly in sedimentary and volcanic rocks of the Applegate Group. Sheared serpentinite is exposed near the upper east edge of the limestone. Sample AVB-138 (Table 1) represents chips of various exposures in the pit.

Sturgis Fork (locality R-6):

Location: Secs. 19 and 20, T. 40 S., R. 4 W., at the junction of Sturgis Fork and Steves Fork of Carberry Creek, about 16 mi from Applegate via Thompson Creek road. Carberry Creek 7½-minute quadrangle.

Owner: USFS land. No development.

The deposit includes two exposures about 110 ft apart in cuts along the south side of the road. The western exposure is about 65 ft wide at road level and pinches out about 40 ft higher. Bedding strikes N. 45° E. and dips 70° SE. The eastern exposure is a lens-shaped layer about 300 ft long forming the north slope of the ridge between the two forks of Carberry Creek. It extends from road level to the top of the ridge about 100 ft maximum elevation. The limestone at road level is massive, smoothly weathered, and therefore difficult to sample by hand.

The limestone is a mix of crystalline calcite and quartz. It is mottled dark gray, light gray, and white and is locally banded. Bands are up to half an inch thick. Associated rocks are mainly argillite of the Applegate Group.

Sample AUB-140 represents a chip channel across the lower part of the western exposure. Samples AUB-152 and -153 (Table 1) represent chip channels each about 80 ft long extending westerly along the lower part of the eastern exposure.

Whiskey Peak (locality R-7):

Location: SW¼ sec. 11, T. 41 S., R. 5 W., at about 5,860-ft elevation on the Devils Climbout road on the southwest flank of Whiskey Peak. Grayback Mountain 7½-minute quadrangle.

Owner: USFS land. No development.

Interlayered marble and metamorphosed clastic sedimentary rocks are exposed in the road cut over a distance of about 135 ft. A cross section paralleling the road and extending west to east consists of the following thicknesses: limestone, 15 ft; rock, 50 ft; limestone, 40 ft; rock, 20 ft; limestone, 10 ft. The limestone is coarsely crystalline and gray to white.

Sample AUB-139 (Table 1) represents chips from various parts of the limestone exposures.

Marble Mountain and Williams Creek area (area S)

This area encompasses the limestone deposits on the south side of the Applegate River between Cheney Creek and Williams Creek within about 15 mi of either Wilderville or Murphy. The largest and most productive limestone deposits in the Oregon part of the Klamath Mountains are included. Chief among them are the Marble Mountain quarry, which furnished limestone for a cement plant at Gold Hill for over 40 years prior to 1967. The Muck, Jones Marble, and Horsehead quarries have produced small amounts of limestone for various uses. Reserve estimates for the Marble Mountain and Jones Marble quarries are 10-12 million and 5 million tons, respectively.

On Marble Mountain are six limestone bodies spaced at irregular intervals in a 2-mi-long chain trending N. 10° E. and lying close to the line between Rs. 6 and 7 W., in the southern third of T. 37 S. The area is drained by Cheney and Crooks Creeks. The Marble Mountain quarry is in the northernmost of these deposits near the top of the north slope of Marble Mountain 3 mi south of Wilderville. The Muck quarry is 0.6 mi south. None of the other deposits has been developed. The deposits are associated with volcanic and volcaniclastic rocks, with some interlayered chert and argillite of the Applegate Formation. Locations of the Marble Mountain and Muck quarries are shown in Figure 27.

Marble Mountain quarry (locality S-1):

Location: SW¼ sec. 19, T. 37 S., R. 6 W., near the top of the north slope of Marble Mountain about 16 mi southwest of Grants Pass. The quarry floor is at about 2,330-ft elevation. Murphy Mountain 7½-minute quadrangle.

Owner: Ideal Basic Industries owns the mineral rights. The surface is separately owned.

Beaver Portland Cement Company initiated production in late 1923. Pacific Portland Cement Company took over operations in 1940, and the company was acquired and merged with Ideal Cement Company in 1952. The latter became part of Ideal Basic Industries after the quarry was closed. The quarry, closed in 1967, has not been operated since.

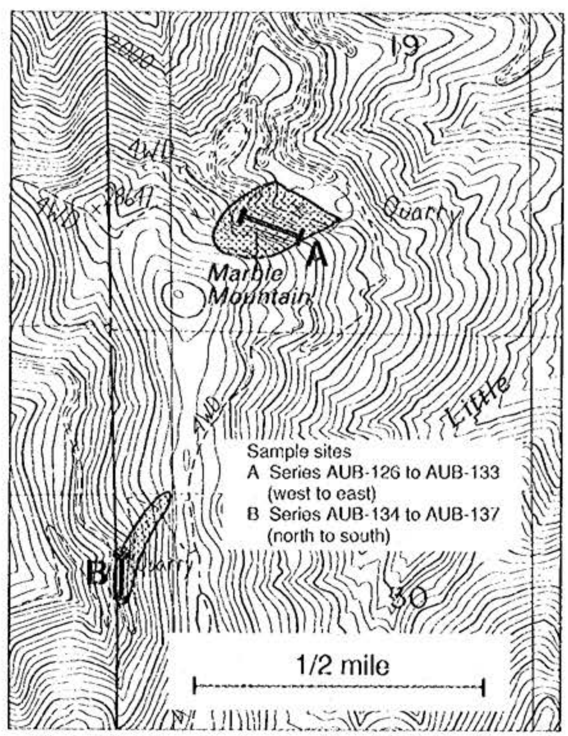

Figure 27. Map showing location of Marble Mountain (locality S-1) and Muck quarries (locality S-2) and sample sites on Marble Mountain. Limestone exposures (patterned areas) are approximately located.

In the early days, limestone was lowered by skip (5,000 ft horizontally and 1,300 ft vertically) from the crushing plant near the mine to a railroad spur at the foot of the mountain. From there it was carried about 28 mi by rail to the cement plant 1 mi west of Gold Hill. After the railroad bridge across the Applegate River was washed out in 1950, the limestone was trucked to the cement plant from the base of the mountain.

Incomplete records of cement and limestone production from the Marble Mountain quarry are given in Table 19. The production figures are from records of the U.S. Bureau of Mines at Spokane, Washington, with permission of Ideal Basic Industries. Pre-1929 records are not available. The total amount of limestone removed from the quarry is probably between 4 and 5 million tons. Most of the limestone was used in cement manufacture. Some of the highest quality stone was used in making paper.

The quarry face is about 750-800 ft wide and 380-400 ft high (Figure 28). The deposit is elongated to the northeast. Its surface area, which is about 1,500 ft long and up to 600 ft wide, extends through 400 ft of elevation. The limestone is fine grained and medium to dark gray in color. White

Table 19. *Production from the Marble Mountain quarry (locality S-1) and the cement plant at Gold Hill, 1929-1967. Figures for 1917-1928 are not available. Data from U.S. Bureau of Mines records, Spokane, Washington.*

Year	Cement produced (tons)	Cement sold (tons)	Paper (tons)	Agricultural limestone (tons)	Other (tons)
1929	50,783	--	--	3,613	--
1930	47,705	--	--	--	--
1931	28,244	--	--	--	--
1932	19,566	--	--	--	--
1933	13,198	11,888	8,912	543	--
1934	31,347	--	--	--	--
1935	48,475	--	--	--	--
1936	31,474	--	--	--	--
1937	35,753	--	25,398	7,715	--
1938	40,381	--	10,896	7,965	53
1939	64,234	--	18,448	2,137	--
1940	51,695	--	--	--	4,897
1941	84,719	--	--	3,711	29,694
1942	103,646	--	--	2,240	30,954
1943	193,186	--	--	940	29,289
1944	60,848	--	--	5,747	31,455
1945	59,814	--	--	4,900	24,306
1946	114,472	--	--	1,182	20,047
1947	119,178	--	--	1,254	13,599
1948	123,152	--	--	--	--
1949	108,296	--	--	4,881	--
1950	98,385	--	--	4,567	--
1951	110,027	--	--	--	--
1952	105,185	--	--	--	--
1953	102,486	--	--	--	--
1954	97,511	125,951	--	--	3,721
1955	122,102	148,485	--	--	3,876
1956	116,787	147,230	--	--	5,759
1957	90,556	128,557	--	--	--
1958	92,301	113,268	--	--	--
1959	101,532	135,506	--	--	6,280
1960	94,901	111,378	--	--	5,075
1961	84,811	86,135	--	--	4,928
1962	110,190	141,838	--	--	5,432
1963	108,991	153,091	--	--	5,531
1964	133,499	166,709	--	--	4,267
1965	--	193,421	--	--	4,330
1966	--	169,758	--	--	4,468
1967	--	41,391	--	--	2,902
Totals	2,915,430	1,622,704	12,858	17,695	211,856

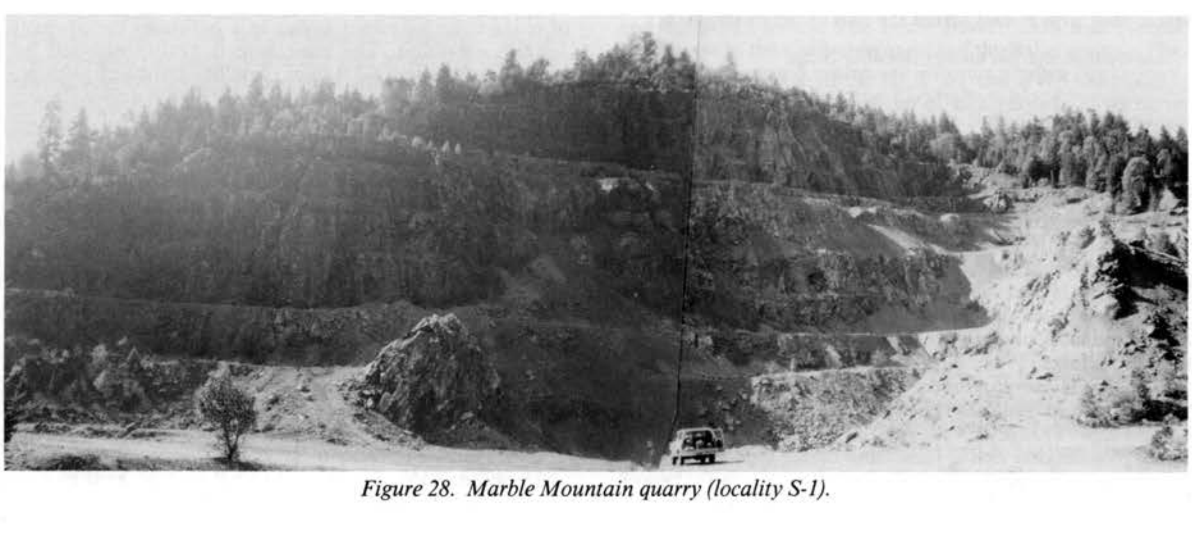

Figure 28. Marble Mountain quarry (locality S-1).

blotches, which may represent the replacement of fossils by calcite, occur locally. Beds vary from 3 to 6 ft in thickness. The limestone is interrupted locally by breccia bodies composed of gray and white limestone fragments in a grayish-green to dark-green chlorite-rich matrix.

Libbey (1957) reported that the quarry stone averages about 95 percent $CaCO_3$, but some bands that run about 99 percent $CaCO_3$ could be quarried when desired. Analyses AVB-126 through AVB-133 (Table 1) represent a series of 100-ft chip samples taken from west to east along a bench about midway between the floor and top of the quarry.

According to Ideal Cement Company reports, diamond-drill results and surface sampling indicate reserves of between 10 and 12 million tons of high-calcium stone.

Muck quarry (locality S-2):

Location: Near the quarter corner between sec. 25, T. 37 S., R. 7 W., and sec. 30, T. 37 S., R. 6 W., about 16 mi southwest of Grants Pass via Highway 199 and roads up Cheney Creek and a branch of Cheney Creek. The quarry is at 2,520-ft elevation on a steep, west-facing slope about 0.6 mi south of the Marble Mountain quarry. Murphy Mountain 7½-minute quadrangle.

Owner: Not determined. Claims are on USFS land.

The history of development is poorly known. Hodge (1938) reported a small output "some years" before his visit. Records in DOGAMI files in the Grants Pass Field Office indicate that some sampling was done on the property by Electro Metallurgical Company in 1945, and five holes were drilled by the same company in December 1947. Limestone Products Company, organized by A.A. Muck and others, shipped ten railcar loads of the limestone to Pacific Carbide and Alloys Company in Portland in 1948-1949.

Development consists of a quarry about 400 ft long with a floor width of about 200 ft (Figure 29). The limestone exposure in the quarry face is about 300 ft long. The deposit is 150 to 250 ft wide, trends N. 30° E. parallel to nearly vertical bedding, and is traceable upslope in that direction for a horizontal distance of about 900 ft. Several large limestone protrusions and cliffs are visible along the strike. A much smaller limestone body is exposed in a road cut at 2,800-ft elevation and separated from the north end of the larger body by about 100 ft of clastic rocks and greenstone.

The limestone is gray, massive, and crystalline and tends to break into fairly large blocks when blasted. Analyses AUB-134 through -137 (Table 1) represent chip samples taken from west to east across the foot of the quarry face.

Horsehead marble quarry (locality S-3):

Location: SW¼ sec. 15, T. 38 S., R. 5 W., about 10 mi southeast of Murphy and 26 mi from Grants Pass. Murphy 7½-minute quadrangle.

Owner: Partly private land; in part BLM claims.

Development of the deposit includes two quarries at about 1,660- and 1,880-ft elevations, respectively, on a northeast-facing slope. Both are about 250 ft long, 35 ft wide, and up to 50 ft deep. Several bulldozer cuts expose parts of the limestone-bearing zone between the two quarries. The lower quarry is near the northeast end of the deposit.

The time when development began is unknown. Oregon Lime Products Company was organized to operate the property in October 1934. A plant producing lime and agricultural products was in operation at that time. The property was operated sporadically during the mid- and late-1930's by Oregon Lime Products Company and during the early 1940's by the Washington Brick, Lime, and Sewer Pipe Company. According to Hodge (1938), a plant constructed on the property was operated in 1936, and burned lime and agricultural products were produced. In 1948, the Horsehead Lime Company built a small modern lime plant at Williams to process limestone from the quarry. The plant was never used. There is no record of substantial activity since that time.

Figure 29. Muck quarry (locality S-2), Marble Mountain-Williams Creek area.

The limestone-bearing zone is about 75 ft wide and traceable for about 1,200 ft trending roughly N. 50° E. Limestone occurs as discontinuous lenses and blocks within the zone. Probably not over half the zone is limestone, although, in places, layers of pure limestone up to 40 ft thick are exposed. Probably not over a third of the width can be mined easily. The limestone is typically coarsely crystalline and white to light gray, with some white and gray mottling.

In his description of the lower quarry, Hodge (1938) stated, "The limestone is interbedded with schist and is cut by basic igneous dikes. The thickest lens in the quarry is about 25 ft, tapering to about 10 ft or less. Waste amounts to about 60 percent of all rock handled."

Only a few truck loads of limestone are visible in the walls of the lower quarry. The amount that is available in extensions beneath the quarry floor is unknown. The upper pit exposes a zone about 40 ft wide consisting in part of very coarsely crystalline, light-gray, nearly translucent marble that is cut by a mafic dike about 15 ft thick. The marble appears to be continuous with surface exposures to the south.

Sample AVB-46 (Table 1) is from a limestone scrap in the west wall of the lower quarry. Sample AVB-47 is a composite of chips from limestone layers in a bulldozer cut at about 1,800-ft elevation. The zone here is poorly exposed but appears to be about 60 ft thick. Argillite and chert are interlayered with the limestone. Sample AVB-48 is a composite of chips across the face of the upper quarry.

Turvey limestone (locality S-4):

Location: E½SE¼NW¼ sec. 29, T. 38 S., R. 5 W., on a ridge west of Williams Creek, about 25 mi from Grants Pass by highway. Williams 7½-minute quadrangle.

Owner: BLM land.

Treasher (unpublished report, DOGAMI Grants Pass Field Office, 1941) reports the occurrence of a limestone lens about 400 ft long and 25 ft wide trending N. 30° E. and dipping 45°-55° SE. between meta-igneous rock on the west and metasediment on the east.

The limestone is white to light gray and coarsely crystalline. It is quite siliceous locally.

Jones marble (locality S-5):

Location: NE¼ sec. 31, T. 38 S., R. 5 W., 23 mi by road south of Grants Pass and 4 mi west of Williams via Kincaid

Road and a road up Marble Gulch. Williams 7½-minute quadrangle.

Owner: Mining claims owned by Brice Campman.

The deposit is well exposed along the crest of a north-trending ridge between 2,300- and 2,900-ft elevation. The main development is a shallow open cut about 200 ft long, 80 ft wide, and 30 ft deep. Several smaller cuts have been made elsewhere in the exposure. Reports by Winchell (1914), Hodge (1938), and Ramp (1962) indicate that the deposit was worked periodically over a period of about 30 years by Al and Lum Jones as a source of monument stone. In 1934, it was purchased by F.I. Bristol. T.T. Leonard later became part owner. About 5,000 tons of agricultural limestone was produced in 1939-40. Jeorg Bleeck acquired the property in 1979 and joint-ventured an exploration project with Genstar Stone Resources, including six diamond drill holes, some more than 200 ft deep. Campman purchased the property in 1988 and has marketed some agricultural limestone from the deposit.

Ramp (1962) described the exposure as crudely boat shaped and about 1,700 ft long and 300 ft wide. The length of the body trends about N. 10° E. The rock is thoroughly recrystallized. Crystal lengths range from 0.3 to 5 mm and average about 1 mm. Most of the rock is white; some is variegated or banded white and gray. Most of it is high-quality. Impurities include a few small lenses, streaks, and knots of quartzite (metachert) and argillite, a diorite dike about 6 ft wide, and a little pyrite locally.

Analyses of four samples (AVB-85 and AWB-901 through -903) are included in Table 1. The purity and strength of the marble make it acceptable for most uses, including carbide and other chemicals, paint and paper filler, and architectural stone.

Ramp (1962) calculated indicated reserves at about 5 million tons. Bleeck (personal communication, 1987) estimated that between 1.5 and 3 million tons of high-quality white stone are available in the central part of the deposit.

Last Chance group (locality S-6):

Location: NE¼NE¼ sec. 31, T. 38 S., R. 5 W., surrounding the three claims of Jones marble property. Williams 7½-minute quadrangle.

Owner: E.W. Morris.

Development includes a narrow road cut several hundred feet long paralleling the hillside about 0.1 mi east, downslope, from the upper cut of the Jones marble deposit. A truck-mounted crushing and screening plant has been set up, and a small amount of marble has been treated. The road cut exposes mostly clastic sedimentary and volcanic rocks of the Applegate Formation. A lens-shaped block of marble about 10 ft thick is exposed near the crusher. Other similar blocks of marble are visible on the hillside above the road. Due to the limited exposure of bedrock, it has not been determined whether the marble blocks represent float from the Jones marble deposit or are part of the stratigraphic section.

Upper Illinois River area (area T)

Holton Creek (locality T-1):

Location: NE¼ sec. 14, T. 39 S., R. 8 W., about 2,700-ft elevation and 5.5 mi east of Highway 199 at Kerby via Kerby Mainline and upper south fork of Reeves Creek roads. Cave Junction 15-minute quadrangle.

Owner: Not determined. No development.

The deposit is a small lens or block exposed adjacent to the access road on the northwest side of the ridge top between Holton and Chapman Creeks. The exposure is about 200 ft long parallel to the ridge and extends downslope to the northwest more than 250 ft in a series of nearly vertical bluffs.

The limestone is finely crystalline and massive, and no bedding was observed. It is gray and cut by veinlets of white calcite. The quality appears to be good, although argillite interbeds occur locally and might be abundant enough to make mining difficult. Analyses AUB-145 and -146 (Table 1) represent chip samples about 150 ft long and 100 ft apart taken parallel to the contour of the slope.

Oregon Caves (locality T-2):

Location: Mainly SE¼ sec. 9 and SW¼ sec. 10, and extending south into NE¼ sec. 16, T. 40 S., R. 6 W., 20 mi east of Cave Junction at the head of Cave Creek between 3,900- and 4,600-ft elevation. Oregon Caves 7½-minute quadrangle.

Owner: Most of the deposit is within the Oregon Caves National Monument (Figure 30).

The deposit is host to the Oregon Caves. The exposure area is about 80 acres in size and irregular in shape. The limestone is crystalline and white to light gray. Locally it is banded or mottled white and gray.

The limestone occurs in massive beds several inches to several tens of feet thick. The cave-tour exit is near the base of a bluff composed of a bed of nearly white marble more than 30 ft thick. An analysis of a single sample (AVB-107) is given in Table 1.

Distribution of float indicates that argillite, chert, and volcanic rocks are locally interbedded with the marble. Argillite underlies the marble along the service road a few hundred feet west of the visitor center. Foliation that appears to parallel bedding strikes about N. 60° E. and dips 10° S. Banding of similar attitude occurs in the limestone near the cave entrance. The cave is about 0.6 mi long. The tour exit is 218 ft in elevation above the entry. Guided tours are conducted several times daily except Christmas.

Morris (locality T-3):

Location: SE¼NW¼ sec. 10, T. 40 S., R. 6 W., on Lake Creek 19 mi east of Cave Junction and about three-quarters

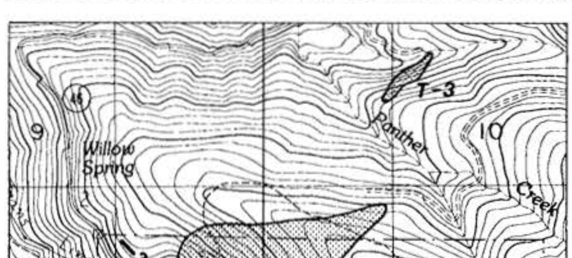

Figure 30. Map of the Oregon Caves (locality T-2) and Morris limestone deposits (locality T-3). Geology by H.C. Brooks and L. Ramp.

of an air-line mile northeast of Oregon Caves. Oregon Caves 7½-minute quadrangle.

Owner: USFS land.

Massive marble forms a northwest-facing bluff that appears to be over 100 ft high on the south bank of Lake Creek (Figure 30). Development consists of a bulldozer cut at the base of the bluff. A few years ago, several hundred tons of the marble were broken and stockpiled on the north side of Lake Creek 0.3 mi west of the site by E.W. Morris.

Ramp (unpublished report, DOGAMI Grants Pass Field Office, 1988) reported that the marble deposit is a small lens about 120 ft thick and 600 ft long and may contain as much as 750,000 tons. The marble is medium to coarsely crystalline, nearly white to gray, and banded and mottled white and gray. Analyses of two samples (AVB-108 and -109) of the stockpiled material are given in Table 1.

Associated rocks include graywacke, argillite, chert, and greenstone. Serpentinite is exposed on the southeast side of the deposit, and diorite is exposed to the south. The deposit is not connected to the Oregon Caves limestone body.

Sucker Creek (locality T-4):

Location: NE¼ sec. 29, T. 40 S., R. 6 W. Oregon Caves 7½-minute quadrangle.

Owner: USFS land. No development.

Limestone blocks that may be part of an old landslide are exposed in the steep upper bank of Sucker Creek in an area about 50 ft long parallel to the road and 30 ft high. The blocks range up to about 10 ft across and are separated by fragmented chert, argillite, greenstone, and minor serpentinite. No limestone was seen on the slope above the cut. Sample AUB-148 is representative of the exposed limestone.

Williams (1914) and Winchell (1914) reported a small crystalline limestone occurrence near the mouth of Grizzly Gulch which is in the southeast corner of sec. 32, T. 40 S., R. 6 W., 4 mi south of the Oregon Caves.

Swan Mountain (locality T-5):

Wells (1940) mapped several small limestone lenses grouped around Swan Mountain in NE¼ sec. 29, T. 40 S., R. 6 W.; secs. 1, 2, 13, and 14, T. 41 S., R. 6 W.; and sec. 7, T. 41 S., R. 5 W. Grayback Mountain 7½-minute quadrangle.

Owner: USFS land. No development.

West Fork Althouse Creek (locality T-6):

Wells and others (1949) show two small limestone occurrences in sec. 16, T. 41 S., R. 7 W., along the West Fork of Althouse Creek just north of the California state line. Cave Junction 15-minute quadrangle.

Owner: USFS land. No development.

Elder Creek (locality T-7):

Location: SW¼NW¼ sec. 25, T. 40 S., R. 8 W., about 500 ft north of the Happy Camp Road and 1.5 mi by road northeast of Takilma at about 1,680-ft elevation. Cave Junction 15-minute quadrangle.

Owner: Not determined.

Development consists of a small pit estimated to be about 50 ft long and 30 ft wide. The pit was filled with water to within 20 ft of the surface so its depth could not be measured, nor could samples be obtained from the pit walls. Sample AUB-147 was selected from a small pile of broken limestone nearby. The limestone is light gray, crystalline, and massive. A small amount was used at a small matte-type copper smelter at Takilma that treated ore from the Queen of Bronze Mine in early days.

Roseburg area (area U)

This area includes several small, widely spaced limestone deposits in a northeast-trending belt about 8 mi south and east of Roseburg and one deposit near Olalla that is 12 mi southwest of Roseburg (Figure 31).

The deposit operated by Oregon Portland Cement Company from 1915 to 1935 is the only one having significant past production. Small production of limestone, mainly for agricultural purposes, has come from the Dodson deposits and from the edges of the Oregon Portland Cement Company quarries. The latter have been sporadically active in recent years. The Hatfield and Oden-Hatfield deposits produced a little limestone for use as dimension stone and for carving many years ago.

The limestone deposits in the Roseburg area were called the Whitsett Limestone lentils by Diller (1898). The deposits occur in the Otter Point Formation, which has been included in the Sixes River terrane regarded as a northward extension of the Franciscan Central Melange Belt of California. Fossils from the limestones are of Middle Cretaceous age.

The limestone typically is gray, and some is pink to white. Much of it is of bioclastic origin, consisting largely of fossil fragments.

Buckhorn limestone (locality U-1):

Location: SE¼NW¼ sec. 14, T. 27 S., R. 4 W., west of Buckhorn road on the divide between Oak Creek and the north fork of Deer Creek. Dixonville 7½-minute quadrangle.

Owner: Not determined. No development.

The deposit consists of a small, 15-ft-thick lens of gray limestone containing microscopic fossils (Ramp, 1972).

Hatfield Ranch (locality U-2):

Location: Southern part of sec. 28 and the northern parts of secs. 31, 32, and 33, T. 27 S., R. 4 W. Dixonville 7½-minute quadrangle.

Owner: Walden J. Hatfield and sons.

At least five small limestone deposits are aligned about N. 75° E. along the lower part of the slope south of the South Fork Deer Creek. They lie within 300 yd of the creek and are less than 300 ft in elevation above creek level. From about 1889 to 1890, a marble saw was operated at the Hatfield deposit. A small amount of limestone from the Hatfield and Oden-Hatfield deposits was quarried and sawed for construction and decorative purposes. There is no record of other work at any of the deposits, which are associated with interbedded sandstone and siltstone. The Hatfield and Oden-Hatfield deposits were briefly described by Hodge (1938) and in DOGAMI Bulletin 14 (Oregon Department of Geology and Mineral Industries, 1940).

In the Hatfield deposit, limestone in the NE¼NE¼ sec. 31, T. 27 S., R. 4 W., occurs as scattered blocks and fragments a few inches to several feet across. Some blocks appear to be part of a small landslide consisting mostly of soil and fragmented sandstone and siltstone. Other blocks were hauled here for sawing from the Oden-Hatfield deposit. The area containing the limestone is about 200 ft in diameter at the base of the slope south of the creek and across the road from an old barn. Minor excavating of the landslide area has been done. Only a few tons of limestone are visible.

The Oden-Hatfield deposit is in the NE¼NE¼ sec. 32, T. 27 S., R. 4 W., about 400 ft south of the creek on the northwest slope of a small spur. The deposit is about 225 ft long and up to 25 ft wide. It strikes N. 75° E. and dips almost vertically. Development consists of an open cut about 45 ft long and 25 ft wide near the western boundary. Colors of the limestone range through pale shades of brown, pink, gray,

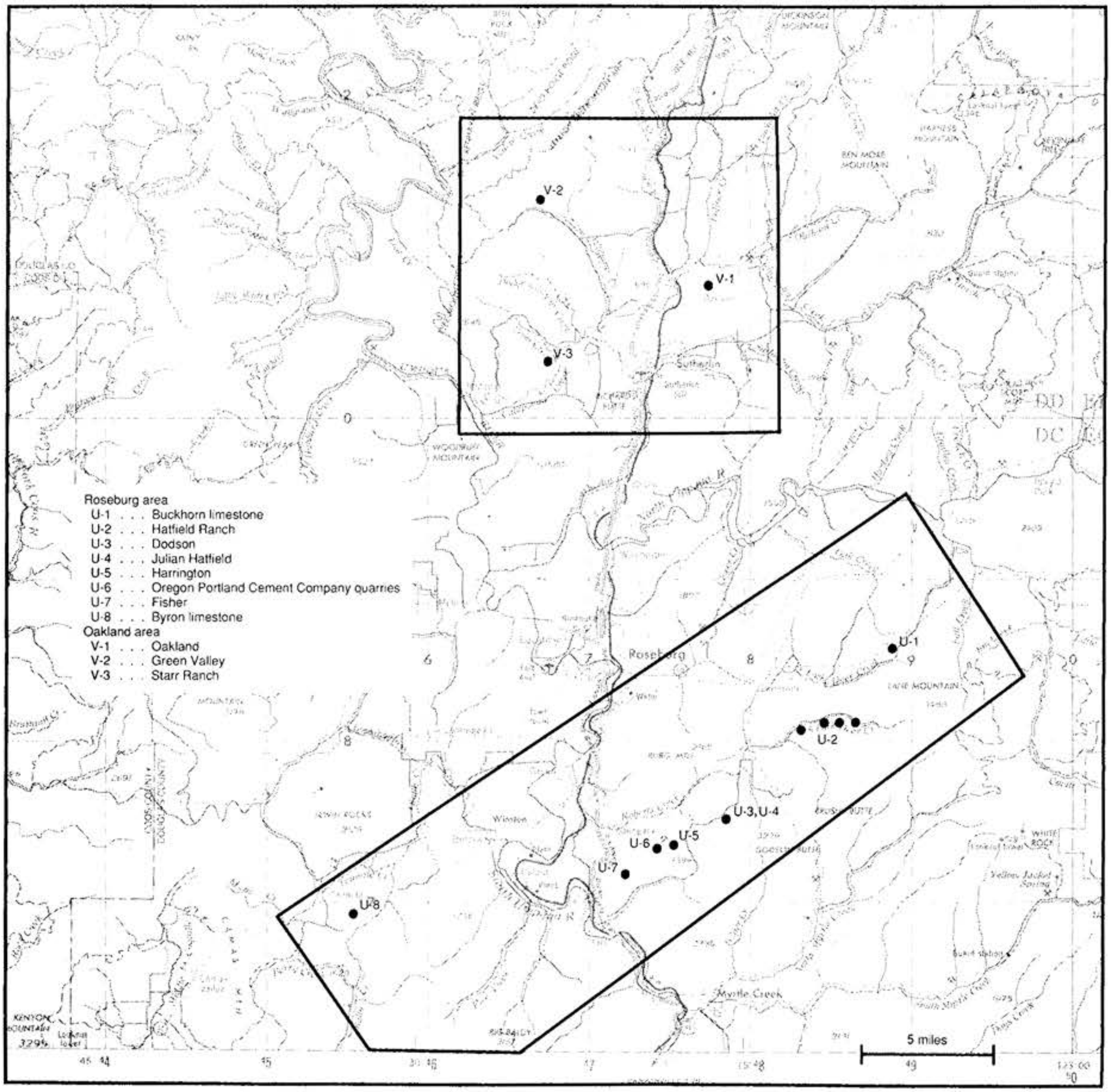

Figure 31. Map showing locations of limestone deposits in the Roseburg and Oakland areas.

and white. The stone is attractive when polished. Some was sawed and used as dimension stone in the old Douglas County court house in Roseburg. An analysis of one sample (AVB-37) is given in Table 1.

The Hatfield 2 deposit is about 800 ft east of the Oden-Hatfield deposit and 50 ft west of the road to the latter deposit. The exposure is about 40 ft long and 25 ft wide and in contact with sandstone on the south. The limestone is similar to that in the Oden-Hatfield deposit. Bedding features strike N. 70° E. and dip steeply.

The Hatfield 3 deposit is at about the 1,160-ft elevation and 0.35 mi east of the Oden-Hatfield deposit. The exposure forms a bluff of massive gray limestone about 70 ft long and up to 20 ft high. The block is surrounded by sandstone. Sample AVB-38 is representative of the limestone.

The Hatfield 4 deposit is at about the 1,150-ft elevation and 0.5 mi east of the Oden-Hatfield deposit. The exposure is a block of massive gray limestone about 25 ft long and 20 ft wide. Thickness of at least 10 ft is indicated in a small cut along the north side of the block.

Dodson (locality U-3):

Location: SW¼ sec. 14, SE¼ sec. 15, T. 28 S., R. 5 W., on a branch of Roberts Creek. Roseburg East 7½-minute quadrangle.

Owner: James W. Day.

A small quarry in SE¼SE¼ sec. 15, about 600 ft south of Roberts Creek road is located on the east side of a shallow draw at about 950-ft elevation. It is in the southern part of a limestone lens that Hodge (1938) said, prior to development, was about 300 ft long and up to 60 ft wide, striking N. 25° E. and dipping steeply to the northwest. The east face of the quarry is about 110 ft high on a 45° slope and about 150 ft long. Several small blocks and lenses of massive limestone separated by sandstone and shale are exposed in the lower part of the quarry. They range up to about 40 ft across, but probably not more than half of the quarry face is limestone. The limestone has a fine sandy texture, is of dirty gray to brownish color, and contains veinlets and clots of white calcite. According to Day (personal communication, 1987), quarrying extended below the present floor level, and the deep hole that existed is filled with material sloughed from the quarry walls. There is no record of the amount of limestone produced. Several thousand tons of material have been removed from the quarry, but how much of it was limestone is unknown. The limestone was ground on the property and sold locally for agricultural use.

Peterson (unpublished report, DOGAMI Grants Pass Field Office, 1960) mapped a small limestone deposit in the SW¼ sec. 14 that he regarded as the northeast extension of the Dodson deposit. It is reported to be about 750 ft long and up to 50 ft wide, although it pinches and swells. The limestone is locally interbedded with sandstone and shale. The southern part of the zone strikes N. 25° E., and the northern part strikes about N. 60° E. Most of the rock is gray, but some is white. Fossil fragments are visible locally. There is no record of development.

Julian Hatfield (locality U-4):

Location: NW¼NE¼ sec. 22, T. 28 S., R. 5 W., about a quarter mile southwest of the Dodson quarry on a south-facing slope. Roseburg East 7½-minute quadrangle.

Owner: Melvin B. Harris. No development.

Peterson (unpublished report, DOGAMI Grants Pass Field Office, 1958) reports that the exposure area is roughly triangular and up to 100 ft wide and 150 ft long, paralleling the strike of the limestone. The deposit dips steeply and strikes N. 35° E. in alignment with the Dodson deposit. The limestone is dark gray, with lighter colored veins of crystalline calcite. Fossil fragments are visible locally. A composite chip sample contained 93.42 percent $CaCO_3$. Coarse- to medium-grained graywacke crops out on both sides of the limestone and may be interbedded with it.

Harrington (locality U-5):

Location: SW¼SW¼ sec. 21, T. 28 S., R. 5 W., about half a mile northeast of the old Oregon Portland Cement Company quarry at 1,350-ft elevation. Myrtle Creek 7½-minute quadrangle.

Owner: George M. Hawks. No development.

R.C. Treasher (unpublished report, DOGAMI Grants Pass Field Office, 1943) reports that the outcrop area is 300 ft by 500 ft, with the long dimension trending N. 45° E. Limestone bluffs 25 ft high occur in the southwestern part of the exposure. Other outcrops are discrete masses presumably in place, but some may be float boulders. The limestone appears to be of uniform quality and is medium grained with some brecciated areas. Color of the limestone is dark gray, with streaks of white calcite. Two grab samples, one by Treasher in 1941 and the other by N.V. Peterson in 1971, assayed 97.6 percent and 93.19 percent $CaCO_3$, respectively. The latter represented chips from outcrops over an area 100 ft wide by 200 ft long.

Treasher further reported that another limestone exposure about 75 ft in diameter occurs about 200 ft northwest of the northeast end of this deposit. The two exposures are separated by sandstone.

Oregon Portland Cement Company quarries (locality U-6):

Location: SE¼ sec. 20 and NE¼ sec. 29, T. 28 S., R. 5 W., at 1,200- to 1,500-ft elevation, about 10 road mi south of Roseburg. Myrtle Creek 7½-minute quadrangle.

Owner: David Sigfridson.

Oregon Portland Cement Company began mining the deposit in 1915 and closed the operation in 1935. The limestone was shipped by rail to Lake Oswego for use in the company's cement plant, which began operating in 1916. Production records are no longer available. During its later years of operation, the mine produced about 250 tons of limestone per day. A 3½-mi-long railroad spur from Carnes on the southern Pacific Railroad served the mine.

Various leasees and the present owner have periodically sold small amounts of ground limestone from the lower and upper quarries to southwest Oregon farms and orchards. Total output of agricultural limestone since 1970 has been about 2,000 tons. About 900 tons were produced in 1987 by D and D Ag Lime and Rock Company of Roseburg. The stone is crushed and ground in a small plant located about 0.1 mi west of the lower quarry.

There are two major systems of underground workings entering the south slope of the hill and a small open cut near the top of the north-facing slope. For descriptive purposes, the workings are referred to here as the lower quarry, middle quarry, and upper quarry. Hodge (1938) indicated that the lower and middle quarries were worked first by glory hole and later by underground open stopes, delivering through crosscut tunnels and surface trams to the tops of two gravity planes discharging into railroad cars.

The workings developed three separate but closely spaced blocks of limestone striking northeast and dipping 50° to 70° SE. The lower two bodies are bounded on the east by quartzite and chert and on the west by ultramafic intrusive rock. The upper one is surrounded by interbedded graywacke and shale.

The upper quarry is about 120 ft across. The limestone is a small block or lens at least 200 ft long and about 60 ft thick in the pit area. The lower contact in the pit area strikes N. 65° E. and dips 50° SE. Bedding in the graywacke above the limestone strikes N. 50° E. and dips 30° SE. The limestone is crystalline, massive, and gray to white in color.

Average analyses of the limestone as delivered at the cement plant during two years, including unavoidable admixture of wall rock, are given in Table 20.

In October 1935, Oregon Portland Cement Company abandoned operations and caved the crosscut tunnels to make the underground workings inaccessible. The last of the spur track was taken up by the end of the year.

Table 20. *Analyses of limestone from Oregon Portland Cement Company quarry (locality U-6), Roseburg area, 1929 and 1930. All values are in weight percent.*

Constituents	1929	1930
SiO_2	3.92	4.11
Al_2O_3	1.64	1.91
Fe_2O_3	0.61	0.72
CaO	51.92	51.68
MgO	0.60	0.64
Loss on ignition	41.11	40.91
Total	99.80	99.97

Fisher (locality U-7):

Location: SE¼SW¼ sec. 30, T. 28 S., R. 5 W., 1½ mi southwest of the Oregon Portland Cement Company quarry. Myrtle Creek 7½-minute quadrangle.

Owner: Private land owned by Fay Fenter. There has been no development.

The deposit is at about 1,620-ft elevation on the Roberts Mountain Ridge between Clark Branch Road and Roberts Creek. It includes an exposure of limestone about 175 ft long and 40 ft wide striking northeast and dipping to the southeast. Hodge (1938) reported that a chip sample of the limestone gave the following analysis. All values are in weight percent.

SiO_2	0.78
Al_2O_3	0.75
Fe_2O_3	0.78
FeO	0.78
CaO	56.46
MgO	0.33
Ignition loss	41.18
Total	100.28

Byron limestone (locality U-8):

Location: NW¼SE¼ sec. 5, T. 29 S., R. 7 W., at about 1,200-ft elevation on the ridge northwest of Olalla Creek, 0.75 mi northeast of Olalla. Camas Valley 15-minute quadrangle.

Owner: John E. Byron and Virginia R. Schwartz. No development.

The deposit is poorly exposed but appears to be an isolated pod about 30 ft long and 20 ft wide. It strikes N. 70° W. and dips 75° S. The limestone is finely crystalline and red to pink, with a few small masses of chert. Treasher (unpublished report, DOGAMI Grants Pass Field Office, 1940) reported assay results of 88.2 and 66.3 percent $CaCO_3$.

Oakland area (area V)

This area includes three small limestone deposits, all within 10 mi of Oakland. The deposits are less than an acre in size, consist of fossiliferous calcareous shale and shaly limestone, and are associated with rhythmically bedded sandstone and siltstone of the Umpqua Formation of Eocene age. There was a little production from the Green Valley deposits prior to 1930.

Oakland (locality V-1):

Location: NW¼ sec. 3, T. 25 S., R. 5 W., about 1 mi northeast of Oakland. Sutherlin 7½-minute quadrangle.

Owner: Not determined. No development.

The deposit consists of bluish, shaly, fossiliferous limestone that Diller (1898) mapped as the Oakland limestone member of the Umpqua Formation. Diller said that the material was quite limited in quantity and not promising for the purpose of making cement. Hodge (1938) reported an exposure of fossiliferous calcareous shale and some interbedded sandstone in a small pit that he surmised was dug to obtain road metal.

Green Valley (locality V-2):

Location: NE¼ sec. 21, T. 24 S., R. 6 W., near the head of Green Valley about 8 mi northwest of Oakland. Tyee Mountain 7½-minute quadrangle.

Owner: Not determined.

Hodge (1938) reported that several hundred tons of fossiliferous calcareous shale were shipped to the Oregon Portland Cement Company from a tunnel that had caved 15 years prior to his visit and from an abandoned quarry, apparently for test purposes.

Starr Ranch (locality V-3):

Location: NW¼ sec. 22, T. 25 S., R. 6 W., about 5 mi west of Sutherlin (4 mi northeast of Umpqua). Tyee Mountain 7½-minute quadrangle.

Owner: Not determined. No development.

The deposit is hard, brittle calcareous shale made up largely of fossil fragments. The beds are thin and interlayered with sandstone and siltstone (Hodge, 1938).

NORTHWESTERN OREGON, COAST RANGE AND CASCADE RANGE

Introduction

Beds of impure bioclastic limestone and calcareous sandstone of Tertiary age occur in parts of Polk and Clackamas Counties. Locations of the deposits are shown on Figure 32. Those near Dallas and Buell are in the eastern foothills of the Coast Range. Those near Marquam are in the western foothills of the Cascade Range.

Most of the limestone production is from quarries a few miles southwest of Dallas—chiefly the Oregon Portland Cement Company quarry, which produced "cement-rock" for the cement plant at Lake Oswego. Smaller quarries southwest of Dallas, one near Buell in Polk County, and one near Marquam in Clackamas County, have produced small amounts of limestone, mainly for agricultural uses. No production has been recorded for any deposit since 1967, when the cement company quarry was closed.

The Polk County deposits are in the Yamhill Formation of Eocene age. Those in Clackamas County are in the Scotts Mills Formation of late Oligocene age. The limestones occur near the base of the two formations and are underlain by old volcanic rocks.

The limestone deposits typically are flat to gently dipping beds consisting of various concentrations of volcanic rock fragments and bioclastic debris including abraded shell fragments, foraminifera tests, and calcareous algae. The cement is calcite. Calcium carbonate content of quarried rock ranged from less than 50 percent to over 80 percent and averaged between 50 and 60 percent.

Descriptions of limestone-bearing areas and deposits

Dallas area (area W)

The deposits in the Dallas area are part of the Rickreall Limestone Member of the Yamhill Formation (Baldwin, 1964). The limestone member intergrades with clastic sedimentary rocks in the basal part of the section, where the sequence laps against the Siletz River Volcanic Series. Sandstone beds more than 40 ft thick and conglomerate beds up to 30 in. thick locally underlie the limestone. The distribution of the Rickreall Member is shown in Baldwin (1964).

The fresh limestone varies from light gray to dark greenish gray, depending upon the amount of dark volcanic and carbonaceous material in it. The weathered rock changes from gray to buff, brown, or iron-oxide red, as leaching of the calcium carbonate and alteration of the volcanic rock fragments progresses. Samples from outcrops are usually lower grade than from fresh rock due to leaching of the calcium carbonate.

Oregon Portland Cement Company quarry (locality W-1):

Location: The quarried area (Figure 33) includes the common corner of secs. 1, 2, 11, and 12, T. 8 S., R. 6 W. It is about 4 mi southwest of Dallas via Oakdale Road. Dallas and Socialist Valley 7½-minute quadrangles.

Owners: David Brinker and Cory Seivert. Oregon Portland Cement Company has retained the mineral rights.

The property consists of about 712 acres. Local relief is about 300 ft, and slopes are gentle. The north quarry is about 600 ft in elevation; the south is about 500 ft. Some limestone was quarried prior to 1911. Oregon Portland Cement Com-

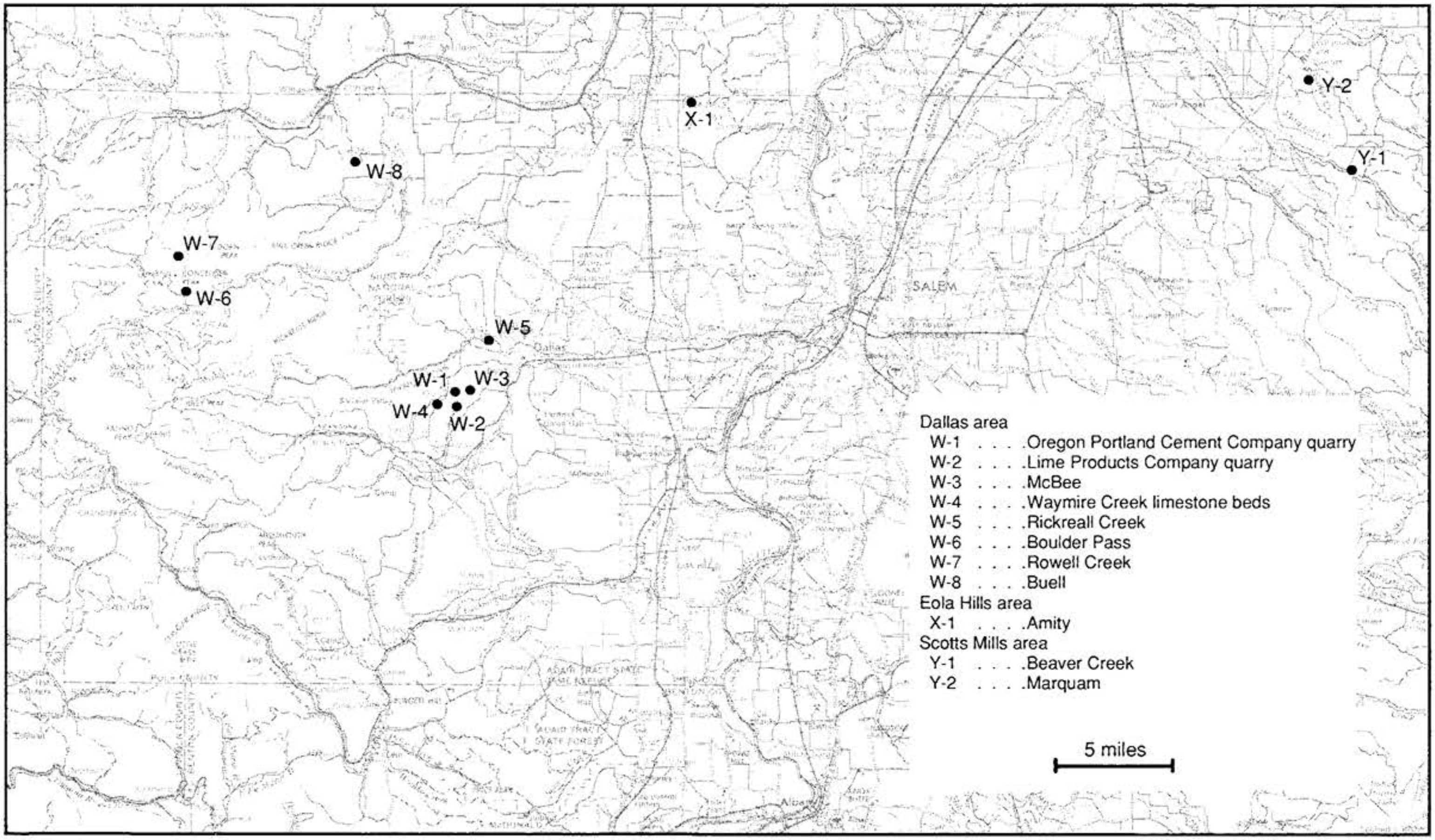

Figure 32. Map showing locations of limestone deposits in northwestern Oregon.

pany operated the quarries from 1915 until 1967 and shipped the limestone to its cement plant in Lake Oswego, Oregon, by rail. The product varied from less than 50 percent to as much as 80 percent $CaCO_3$. Stone from the north quarry averaged 55 percent $CaCO_3$. Because the $CaCO_3$ content was below minimum requirements for portland cement, the limestone was blended with higher quality limestone obtained initially from company-operated quarries near Roseburg until 1935 and later from the company quarry at Lime in eastern Oregon. Production records are scarce for years prior to 1954. Production in 1935 and 1936 was 16,207 and 32,000 tons, respectively (Hodge, 1938). Libbey (1957) noted that production in 1957 was about 500 tons per day with a crew of 31 men. Production recorded by the U.S. Bureau of Mines for the years 1954-1967 totals 1,538,719 tons, and all but 3,068 tons was used in cement. Production decreased sharply after 1963, when the Lake Oswego plant began utilizing limestone from Texada Island, British Columbia.

The quarry covers about 50 acres and is about 50 ft deep in most places. The quarry was served by a 3-mi-long spur from the Falls City branch of the Southern Pacific Railroad. Another half mile of narrow-gauge rail was used to carry limestone from the quarry to crusher and storage facilities. According to Baldwin (1964), however, trucks were used at that time.

According to Allen (1946), the limestone was at least 75 ft thick in the north quarry and more than 50 ft thick in the south quarry, where basalt is exposed in the floor. Beds in the south quarry dip up to 14° to the south; in the north quarry they dip about 5° to the east. The regional dip is generally easterly, at low angles. Most of the fresh limestone in the quarry walls is dark gray and thick bedded.

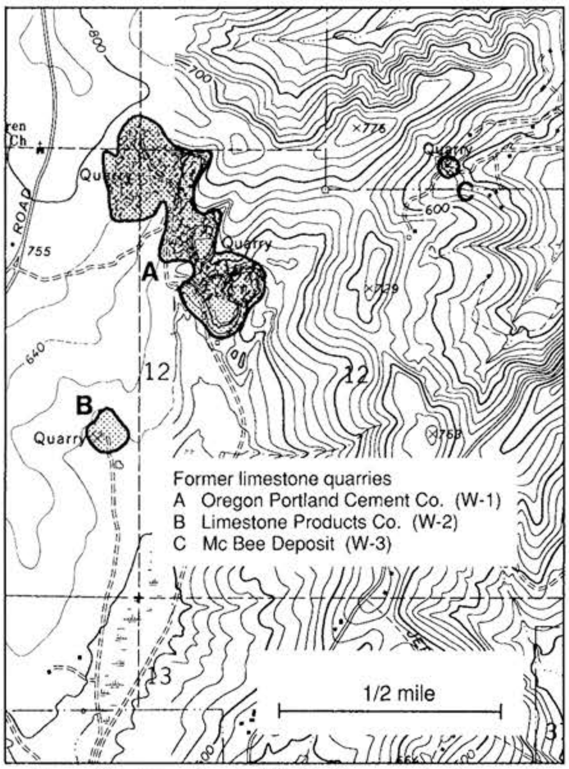

Figure 33. Map of part of the Dallas area showing location of former limestone quarries.

Lime Products Company quarry (locality W-2):

Location: NE¼SE¼ sec. 11, T. 8 S., R. 6 W., about 5½ mi southwest of Dallas via Liberty Road. The property consists of about 96 acres of deeded land (Figure 33) and is about half a mile south of the old Oregon Portland Cement Company quarry. Socialist Valley 7½-minute quadrangle.

Owner: T.T. Leonard estate.

Development consists of an open pit estimated to be about 250 ft across and from 12 to 40 ft deep. The pit area is largely overgrown with trees and brush.

The mine is equipped with crushing and grinding facilities, including crusher, tube mill, and a rotary kiln 38 ft long, all of which appear to have been used very little.

The quarry was opened prior to 1929, and agricultural limestone for use by farmers in the Willamette Valley was produced intermittently through 1959 and perhaps longer. Annual production figures and the names of various operators as recorded by the U.S. Bureau of Mines are presented in Table 21. According to Beatrice Vandiver, daughter of Mr. Leonard (personal communication, 1987), the plant was operated also in the early 1970's.

Table 21. *Production statistics from Lime Products Company quarry (locality W-2), Dallas area. Data from U.S. Bureau of Mines records, Spokane, Washington.*

Year	Operator	Production
1929	Oregon Lime Products	6,188
1937	Limestone Products, Inc.	5,519
1938	Limestone Products, Inc.	6,329
1939	Limestone Products, Inc.	3,225
1941	Limestone Products, Inc.	4,157
1942	Limestone Products, Inc.	7,121
1943	Limestone Products, Inc.	5,322
1944	Limestone Products, Inc.	7,453
1945	Limestone Products, Inc.	6,200
1946	Limestone Products, Inc.	5,480
1947	Limestone Products, Inc.	5,747
1950	Limestone Products, Inc.	7,658
1951	Limestone Products, Inc.	5,234
1953	Polk County Lime Co.	5,055
1954	Polk County Lime Co.	2,757
1955	Polk County Lime Co.	2,965
1956	Polk County Lime Co.	3,274
1957	Polk County Lime Co.	2,685
1958	Polk County Lime Co.	1,912
1959	Polk County Lime Co.	2,000
Total		96,281

The limestone beds on the Lime Products Company's property are an extension of the Rickreall Limestone Member mined at the Oregon Portland Cement Company quarry half a mile to the north. Characteristics of the limestone in the two quarries are very similar. The beds in the Lime Products Company quarry strike about N. 10° E. and dip 5° to 10° S. The limestone thins or is eroded south of the quarry.

The property was drilled during 1956-1958. Forty-seven holes were drilled to depths of as much as 211 ft. Analyses of portions of selected holes are shown in Table 22. The sample data and following information are from a private report prepared for T.T. Leonard by Ernest H. Lund and Lloyd Staples and dated July 1958.

Based on the drilling, a 68.8-acre tract including the existing quarry is estimated to contain 8.6 million tons of limestone. Of this, approximately 90 percent, or nearly 8 million tons, contains 60 percent or more $CaCO_3$. In a later private report for T.T. Leonard, Kent B. Diehl said that adjacent tracts totaling 223 acres contain an additional 19,720,000 tons of limestone, but no grade figures were given.

The limestone grades downward into tuffaceous siltstone and sandstone but in places rests directly on basalt. The total thickness of the carbonate-bearing bed over a large part of the

Table 22. *Analyses of samples from selected drill holes, Lime Products Company property (locality W-2), Dallas area. Data from a private report prepared for T.T. Leonard by E.H. Lund and L.W. Staples in 1958. Analyses by Charleton Laboratories, Portland, Oregon.*

Hole no.	Depth (ft)	$CaCO_3$ (wt.%)
1	62-72	65.5
	72-82	60.5
	82-92	62.1
	92-102	60.6
	102-112	61.4
	112-122	50.5
5	100-110	53.4
9	20-32	66.9
	32-44	57.6
14	61-71	58.9
15	60-70	63.4
	70-80	63.4
	80-90	66.9
	90-100	68.7
	100-110	56.7
	110-120	43.7
20	92-102	57.6
	102-112	60.9
23	68-80	62.1
	80-90	60.6
	90-101	61.9
25	30-40	61.2
	40-50	63.6
	50-60	67.0
	60-70	61.9
	70-80	44.0
	80-90	32.1
	90-100	33.6
	100-110	27.0
	110-120	15.5
	120-131	17.2
40	130-140	58.0
	140-150	51.5
	150-160	49.4
	160-170	29.6
41	95-105	56.8
	105-115	53.5
	115-125	41.0
	125-135	35.7
	135-145	41.2
	145-155	31.1
	155-165	20.9
44	33-43	65.5
	43-53	66.5
	53-63	72.0
	63-73	65.6
	73-83	60.0
	83-93	57.2

property is as much as 100 ft, but because the limestone grades into noncarbonate clastic sediments at depth, only the upper part of the bed has commercial limestone. The thickness of the part that contains 45 percent or more $CaCO_3$ varies from place to place, but, in general, there is a thinning to the south and west.

The thickness of overburden varies from a few feet in the vicinity of the quarry to over 100 ft at a number of places on the property. Quarrying could be continued westward from the present quarry site where the overburden is thinnest. Perhaps as much as 3 million tons of limestone could be removed before underground operations or deep excavations would be necessary.

McBee (locality W-3):

Location: NE¼ sec. 12, T. 8 S., R. 6 W., half a mile west of Liberty Road and 2.7 mi southwest of Dallas, 500-ft elevation. Dallas 7½-minute quadrangle.

Owner: Not determined.

Development includes a small quarry from which a small amount of impure limestone has been produced and used for agricultural purposes. Stone from this quarry was used in constructing the Polk County court house in Dallas.

According to Baldwin (1964, p. 48), this exposure represents the farthest eastward that the Rickreall Limestone Member has been traced. As the limestone seems to parallel the slope, there is the possibility that some of it has been stripped.

Waymire Creek limestone beds (locality W-4):

Location: Secs. 10 and 11, T. 8 S., R. 6 W. Dallas 7½-minute quadrangle.

Owner: Not determined.

Baldwin (1964, p. 48) reports that impure limestone beds of the Rickreall Limestone Member parallel Oakdale Road along Waymire Creek from the upper bridge southwestward for more than a mile. The beds strike N. 65° to 80° E. and dip 7° to 10° S. and may be nearly 100 ft thick. Although the lime content has not been determined, a few of the beds cropping out in the road appear to be of good quality.

Rickreall Creek (locality W-5):

Location: Secs. 30 and 31, T. 7 S., R. 5 W. Dallas 7½-minute quadrangle.

Owner: Not determined. No development.

As described by Baldwin (1964), about 8 ft of weathered limestone of the Rickreall Member crops out in Rickreall Creek, where the creek crosses the line between secs. 30 and 31. Two grab samples of the more solid rock near the base yielded the following:

Sample no.	$CaCO_3$ in wt. percent
P-27358	48.10
P-27359	63.17

Boulder Pass (locality W-6):

Location: Secs. 13 and 24, T. 7 S., R. 8 W., between Boulder Pass and the head of Mill Creek at elevations ranging from 2,500 to 2,900 ft. Laurel Mountain 7½-minute quadrangle.

Owner: Not determined. No development.

Baldwin (1964) described the deposit as a 50-ft-thick section of impure limestone of the Rickreall Member striking N. 35°-40° E. and dipping 10°-12° SE. He mapped the exposure as a narrow band on a steep slope and overlain by an areally extensive gabbro sill. Four samples selected by Baldwin from various parts of the limestone beds and assayed by L.L. Hoagland, DOGAMI chemist, averaged 67.9 percent $CaCO_3$.

Sample no.	$CaCO_3$ in wt. percent
P-5426	59.45
P-5427	86.68
P-5428	60.52
P-5429	64.60

The sill caprock would prevent quarrying far into the hill, but the deposit could be worked along the hill for several hundred yards.

Rowell Creek (locality W-7):

Location: Secs. 11 and 12, T. 7 S., R. 8 W. Laurel Mountain 7½-minute quadrangle.

Owner: Not determined. No development.

Baldwin (1964) describes the deposit as follows: "Limestone similar to, and in the same stratigraphic position as, the deposit near Boulder Pass crops out where the old Polk Operating Company's railroad crossed the Rowell Creek-Rock Creek drainage divide...The deposit is probably not as thick as the limestone near Boulder Pass or at the Oregon Portland Cement Company's quarry, but drilling and further exploration might indicate more tonnage than is now apparent. A grab sample contained 63.37 percent $CaCO_3$."

Buell (locality W-8):

Location: Secs. 19 and 20, T. 6 S., R. 6 W., about 2 mi northwest of Buell and about 400 ft south of State Highway 22 (Figure 34). Sheridan 7½-minute quadrangle.

Owner: Lawrence Wright.

Development includes two small open pits about 300 ft apart. The larger is about 240 ft long, 125 ft wide, and 20 ft deep at the face that has been extended into a gentle westward slope. Approximately 24,000 tons of rock have been removed from it. The other pit is near the creek bottom and is overgrown with willows and brush, so its size is hard to determine, although it appears considerably smaller.

Hodge (1938) said the property was investigated by the Oregon Portland Cement Company in 1932. The average $CaCO_3$ content of six drill holes averaging 44 ft deep was 27.16 percent. Buell Lime Products Company leased the property in 1946, and, by early March, 13 holes had been drilled, 3,000 tons of limestone had been quarried, and construction of bunkers and grinding and weighing facilities was underway. Quarry operations continued into the early 1950's. There was some production in 1954. Ground limestone was marketed for argicultural use.

Bedded, impure, sandy limestone is exposed in the larger pit and in several places on the side of a shallow northwest-sloping draw extending above and below the pit. The beds strike N. 60° W., vary in dip from about 6° to 15° N., range from a few inches to 4 ft or more in thickness, and are cut by widely spaced steep fractures. The fresh limestone is typically a greenish-gray color. Weathered surfaces are green to brown. Nearly white fossil fragments are abundant locally. Analyses of two samples (AVB-110 and -111) taken by the writer in 1987 appear in Table 1.

The location of the 1946 drill holes, abbreviated logs of the drill holes, and the analytical results of sampling done by Lowry and Mason in 1946 are given in Allen (1946), Mason and Lowry (unpublished report, DOGAMI Grants Pass Field Office, 1946), and Oregon Department of Geology and Mineral Industries (1951). Reported thicknesses of the limestone in the various holes ranged from 14 to 23.5 ft and averaged 19.5 ft. Six of the holes bottomed in limestone.

Results of the drilling and surface investigations indicate an average thickness of at least 20 ft over an area of 300 by 1,500 ft. Total reserves in this area of approximately 646,000 tons are indicated. By further extension of the area from outcrop indications, an inferred reserve of 1.55 million tons is obtained.

The limestone is in the lower part of the Eocene Yamhill Formation and in the same stratigraphic position and lithologically like the Rickreall Limestone Member, which contains the limestone deposits southwest of Dallas 10½ mi to the southwest (Baldwin, 1964).

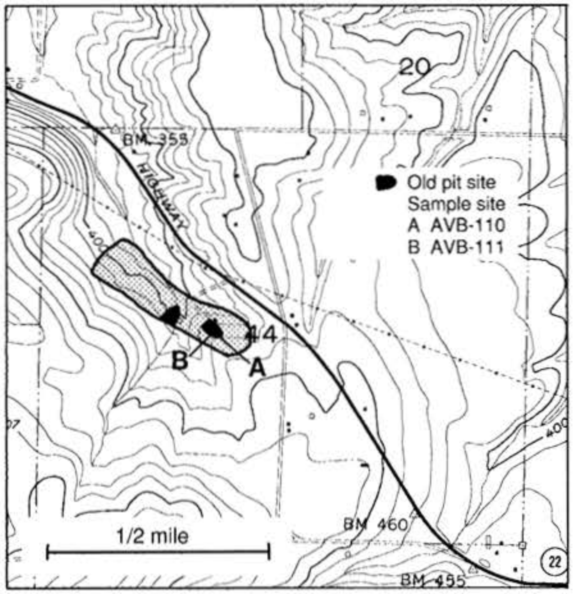

Figure 34. Map showing location and approximate boundaries of the Buell limestone deposit (locality W-8).

Eola Hills area (area X)

Amity (locality X-1):

Location: NE¼ sec. 9, T. 6 S., R. 4 W., 3 mi south of Amity in the foothills of the Eola Hills and about 1 mi east of U.S. Highway 99W, at about 225-ft elevation. Amity 7½-minute quadrangle.

Owner: Not determined.

Allen (1946) said that one limestone lens or possibly two lenses strike north and dip a few degrees west down the slope. The limestone is interbedded with a fine-grained white marine fossiliferous tuff. Because outcrops are scanty, the length and width of the lenses could not be determined. The lime content of the rock is variable, but probably averages about 50 percent.

Scotts Mills area (area Y)

The two deposits described here are in the low foothills of the Cascade Range on the eastern edge of the Willamette Valley in southwestern Clackamas County. The Beaver Creek deposit is undeveloped. The Marquam deposit has produced several thousand tons of impure limestone for agricultural uses in the Willamette Valley. Both deposits are in the Marquam Member of the Oligocene Scotts Mills Formation of Miller and Orr (1986).

Beaver Creek (locality Y-1):

Location: SW¼ sec. 19, T. 6 S., R. 2 E., about 3 mi east of Scotts Mills on Beaver Creek road. Wilhoit 7½-minute quadrangle.

Owner: Not determined.

Calcareous tuff of the Marquam Member of the Scotts Mills Formation is exposed along the road and in the bank of Beaver Creek. The extent or thickness of the deposit is unknown. Peterson and Mason (1958) report that a grab sample contained 50 percent $CaCO_3$. The deposit is unexplored and undeveloped.

Marquam (locality Y-2):

Location: Near the center of the NW¼ sec. 2, T. 6 S., R. 1 E., about 2 mi by road northeast of Marquam and on the west slope of a broad, north-trending ridge between 300- and 370-ft elevation. Scotts Mills 7½-minute quadrangle.

Owner: James P. Allen. Mineral rights to five acres including the quarry site are owned by the T.T. Leonard estate. Much of the area is farm and pasture land.

Development consists of an irregularly shaped open pit (Figure 35) of about half an acre, averaging 5 ft deep, that is included in an area about 300 ft long by 100 ft wide that has been stripped of soil and leached rock. About 6,000 tons of rock have been removed from the shallow quarry. Most of the production was made during the 1940's and 1950's by T.T. Leonard and sold for agricultural purposes.

Figure 35. Abandoned quarry at the Marquam deposit (locality Y-2), Scotts Mills area.

Hodge (1938) reported two limestone exposures in this area, one covering 10.38 acres and the other 3.96 acres. He said that 14 drill holes, averaging 14 ft deep, indicated that the limestone has an average thickness of 9 ft and reserves total about 5 million tons, averaging 70 percent $CaCO_3$. The $CaCO_3$ content of limestone from seven holes drilled later by T.T. Leonard ranged from 30.5 to 53.1 percent.

The limestone occurs near the base of the Marquam Member of the Scotts Mills Formation in association with exposures of older basalt. It consists of a sandy to silty aggregate of marine shell fragments that are mainly small oysters and other carbonate particles, altered basaltic rock fragments, sand, silt, clay, and a little carbonaceous material including petrified wood. Fresh surfaces are light to dark gray. Weathered surfaces are brownish to dark greenish gray. Results of analysis of one grab sample (AVB-112) are shown in Table 1.

In addition to the Marquam site, small isolated patches of impure shell-bearing limestones occur along Butte Creek east of Scotts Mills.

Isolated deposits in western Oregon (area Z)

Unnamed (locality Z-1):

Location: Sec. 29, T. 30 S., R. 14 W., about 5 mi northeast of Langlois (Peterson and Mason, 1958). Langlois 7½-minute quadrangle.

Owner: Not determined. No development.

According to Ramp and others (1977), a few, very small limestone deposits occur in the Otter Point Formation; none of those observed or described is more than a very few feet thick, and they pinch out rapidly along strike.

Brown (1942) says the limestone is finely crystalline, light gray, siliceous, and probably equivalent to the Whitsett limestone lentils in the Roseburg quadrangle.

Morgan limestone (locality Z-2):

Location: NE¼ sec. 35, T. 25 S., R. 12 W., on the hillside west of the South Fork Coos River, 250 ft above the highway and about 7 mi east of Coos Bay. Daniels Creek 7½-minute quadrangle.

Owner: Not determined.

The deposit is reported to be 10 to 25 ft wide and traceable along the strike (N. 65°-70°E.) for about 750 ft (Baldwin and others, 1973). The limestone is dull gray and amorphous, with many veinlets and small patches of calcite. The results of two assays follow.

The first assay is from Hodge (1938). All values are in weight percent:

SiO_2	10.57
Al_2O_3	4.27
Fe_2O_3	2.96
MgO	1.35
CaO	42.97
CO_2	33.47
Total	95.59

The second assay is from the Oregon Department of Geology and Mineral Industries (1940) and was done by a chemist from the Coos Bay Pulp Corporation. All values are in wt. percent:

Insoluble (boiling dilute HCl)	10.58
R_2O_3 (iron and aluminum oxide)	5.28
$CaCO_3$ (calcium carbonate)	79.25
$MgCO_3$ (magnesuim carbonate)	3.75

The deposit is associated with sandstone and conglomerate of the Flournoy(?) Formation of Eocene age. Estimated reserves are 80,000 tons. A small amount of this rock was used locally for mortar in early days.

Nestucca River (locality Z-3):

Location: T. 3 or 4 S., R. 7 or 8 W.

Larry Growney (personal communication, March 11, 1988) reported that limestone is exposed in a road cut along the Nestucca River about 5 mi east of Blaine in Tillamook County. The limestone is brownish gray, and one small chip sample was 95 percent soluble in hydrochloric acid. The deposit is overlain by volcanic breccia in the core of a small asymmetric anticline. Dimensions of the deposit were not determined due to poor exposure.

Faucet Creek deposit (locality Z-4):

Location: Secs. 9 and 10, T. 2 S., R. 9 W. Tillamook 7½-minute quadrangle.

Owner: Not determined.

Hodge (1938) reported that a 4-ft bed of dense gray limestone is traceable for 300 ft along Mill Creek in the NE¼NE¼ sec. 9, T. 2 S., R. 9 W. Very little of the limestone is exposed above creek level. Williams (1914a) and Hodge (1938) mentioned a report by Collier on an occurrence in the NW¼NW¼ sec. 10, from which 500 tons was quarried in 1914. Reserves of 10,000 tons were estimated. The limestone was burned for lime and used as whitewash and mortar. His analysis showed the following contents in weight percent: $CaCO_3$, 82.4; $MgCO_3$, 2.8; SiO_2, 9.3; Fe_2O_3, 1.8; and Al_2O_3, 4.0.

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APPENDIX

LABORATORY PROCEDURES

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SAMPLES

Samples in chunk form and of 1 to 4 kg weight were received in the Department of Geology and Mineral Industries (DOGAMI) laboratory. The analyzed samples consisted of the following:

Field season	Laboratory identity	No. of samples
1986	AUB-001 through AUB-174[1]	173
1987	AVB-001 through AVB-115	115
1988	AWB-001 through AWB-003	3
1986	Blind samples	9
—	Standard reference materials	6

[1]AUB-058 was missing.

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The following laboratories provided their services for this project:

1. Oregon Department of Geology and Mineral Industries (DOGAMI) laboratory, Portland, Oregon.
2. X-Ray Assay Laboratories Ltd. (XRAL), Don Mills, Ontario, Canada.
3. Bondar-Clegg Ltd. (B-C), North Vancouver, British Columbia, Canada.
4. Nuclear Activation Services, Inc. (NAS), Ann Arbor, Michigan.

SAMPLE PREPARATION

Samples for chemical analysis, brightness, and X-ray diffraction

The DOGAMI laboratory crushed the 1986 and 1988 samples to minus ¼-in. mesh in a Braun crusher equipped with steel jaws. The 1986 samples were further reduced in size by passing through a Braun pulverizer with the steel plates set at ⅛-in. separation. XRAL crushed and split the 1987 samples.

For each sample, the crushed material was split the number of times required to obtain a subsample of about 250 grams (g). By random addition or removal of material, a subsample of 250 ± 0.5 g was obtained.

XRAL ground each of the 250-g subsamples to minus 200 mesh in a Herzog ring-and-puck mill equipped with silica grinding media. Because of sample size and limited mill volume, grinding of a sample required several runs. The runs were combined, placed in a jar, and homogenized on a rolling mill. Each subsample was then split into two parts and separately packaged.

Samples for gold analysis

An approximately 100-g split of the crushed material was ground to minus 200 mesh in a ring-and-puck mill equipped with chrome steel grinding media. NAS ground the 1986 limestone samples; DOGAMI ground the 1987 limestone samples. The limited number of limestone samples that were analyzed for gold were selected using "high" silica content as a criterion.

CHEMICAL ANALYSIS

XRAL provided the major- and minor-oxide, trace-element, and loss-on-ignition (LOI) values reported in Table 1 (Plate 1). A description of their methods is quoted below:

> Whole-rock analysis by X-ray fluorescence spectrometry
>
> A 1.3-g sample after roasting at 950°C for one hour is fused with 5 g of lithium tetraborate, and the melt is cast into a 40-mm button.
>
> The button is analyzed on a Philips PW1600 simultaneous X-ray fluorescence spectrometer. This system is calibrated using more than 60 reference materials, most of them being tabulated in Syd Abbey's "preferred" values compilation (Geological Survey of Canada, 1979).
>
> Counting time on major elements is 60 seconds, and each of them is analyzed for through its own fixed channel. Trace elements in this package run as counts are accumulated for the majors using a scanner.
>
> LOI is obtained from the roasting mentioned above. All elements determined are added, and any samples with a sum of less than 98 percent or higher than 101 percent are automatically repeated. This gives us control over the button preparation. Instrument precision on most elements is better than 0.5 percent. Only on lower count rates would one experience errors of 1-2 percent.

The acid insoluble data were provided by two laboratories: XRAL and B-C. XRAL used the Standard Method of ASTM C-25. The method used by B-C was similar to the optional method of that standard.

BRIGHTNESS

Brightness refers to the response of a sample to illumination in the blue end of the spectrum. The more blue a shade of white is, the brighter it appears to be. The units of the measurement are in percent, with the reflectance (i.e., brightness) of a specially prepared block of magnesium carbonate being 100 percent. However, brightness readings are reported as dimensionless numbers.

Brightness of materials in powder form is dependent, in part, on the size and distribution of sizes of the particles. High-quality natural limestone produced for filler applications is very fine sized (largely in single-digit-micron size), its size distribution has a narrow range, and it has a brightness of 95 or higher.

The tests were performed in the DOGAMI laboratory using a Photovolt model 577 digital reflectance meter equipped with a "T" search unit and blue filter. The instrument was calibrated according to the manufacturer's instructions. The calibrating standards were a black cavity (reflection value of zero) and a standard plaque (reflection value of 85.0); both were supplied by Photovolt.

The analytical procedure consisted of (1) setting up the calibration curve with the black cavity and standard plaque, (2) rechecking the curve with the two standards, (3) recalibrating the instrument if either value was more than 0.2 units outside of the standard values, (4) reading of five samples, and finally (5) reading the two standards as samples. Short-term stability was good enough that recalibration and rereading of samples were rarely required.

The samples consisted of the minus 200 mesh material prepared as described above. Enough of the sample was placed in a special glass cuvette to form a layer about an eighth of an inch thick when compacted. Compaction was done with a wood cylinder slightly smaller than the inside diameter of the cuvette. The resultant flat surface against the glass bottom was read upward through the bottom (the cuvette is positioned above the sensor unit).

Note: The brightness readings given in Table 1 (Plate 1) are considered approximations for the following reasons: (1) Sample particle size, minus 200 mesh (75 microns), was coarse relative to a finished product's particle size, and, as a result, the brightness readings were likely lower. (2) A series of replicate readings, on separate portions of a number of samples, exhibited fair to good reproducibility; the differences appeared to be sample rather than instrument related. (3) The instrument manufacturer recommends the use of plaques for standardization with a reflectance value close to that of the sample; thus sample readings under about 80 and over about 90 may not be accurate.

MINERALOGY BY X-RAY DIFFRACTION (XRD)

XRD scans on selected samples were performed in the DOGAMI laboratory for major constituents ("bulk" XRD) or for minor mineral constituents in high-purity limestones. The latter were determined in specially prepared acid insoluble fractions.

The minus 200 mesh samples were prepared as powder pack mounts for analysis on a Norelco instrument with nickel filtered copper radiation. The samples were scanned from 5° to 55° 2 theta at a rate of 1° 2 theta per minute. The XRD patterns were used to estimate the relative amounts of the minerals identified. See Table 23.

GOLD ANALYSIS

NAS performed the analyses for gold. The method employed was fire-assay preconcentration of the gold in a 20-g sample (the gold was collected in added silver), acid dissolution of the resultant silver-gold bead, and a finish by directly coupled plasma (DCP) emission spectrometry. NAS's detection limit for gold content determined by this method was specified as 1 part per billion (ppb).

The 1986 and 1987 samples were analyzed in separate batches and at different times. Perusal of the two sets of data suggests that there is some systematic error. Additionally, while there appear to be several anomalous gold values, there were no replicate analyses by a second laboratory to confirm the data. The use of statistical methods to identify anomalies was beyond the scope of this report. See Table 24.

QUALITY CONTROL

Sample preparation

The crushing, splitting, grinding, and homogenizing, done to standard practice, were expected to produce a representative subsample. A second subsample prepared in the same manner was obtained for nine samples. These subsamples, labeled "blind" in the table of replicate analyses (Table 25), were prepared and analyzed to assess the sample preparation procedure.

Chemical analysis

As the chemical composition of limestone is of major importance in determining potential uses, the analytical methods chosen for analysis must give reliable results. The X-ray fluorescence (XRF) method selected is capable of producing reliable results at modest cost and with good turnaround. As the XRF (and bulk of the other chemical) analyses were performed in an outside laboratory, DOGAMI

Table 23. *X-ray diffraction mineralogy for selected limestone samples.*

Sample no.	Calcite	Dolomite	Quartz	Feldspar	Illite	Serpentine	Other components
Whole rock							
AVB-78	M	--	--	--	--	--	--
AVB-39	M	--	tr	--	--	tr	--
AVB-46	M	--	--	--	--	--	--
AVB-50	M	M	--	--	tr	--	--
AVB-60	M	M	--	--	tr	--	--
AVB-65	M	tr	tr	tr	--	--	--
AVB-93	M	tr	--	--	--	--	--
AVB-100	--	M	--	--	--	--	--
AVB-108	M	--	tr	--	--	--	--
AVB-114	m	M	--	--	--	--	--
AVB-110	M	--	tr	tr	--	--	tr analcime
AUB-20	M	m	--	--	--	--	--
AUB-47	M	--	tr	--	--	--	--
AUB-94	M	tr	tr	--	--	--	--
AUB-103	M	--	tr	--	--	--	--
AUB-122	M	m	--	--	tr	--	--
AUB-149	M	--	tr	--	--	--	--
AUB-161	M	--	--	--	--	--	tr clinoptilolite
AUB-154	M	--	tr	--	--	--	--
AUB-173	M	--	--	--	--	--	--
AVB-10	M	tr	tr	--	--	--	--
AVB-40	m	M	--	--	--	--	minor actinolite/tremolite

M = major component.
m = minor component.
tr = trace.

Insoluble residue

AUB-32	Major: quartz; minor: chlorite, amphibole
AVB-47	Major: amphibole (actinolite/tremolite)
AVB-85	Major: quartz
AVB-86	Major: quartz
AVB-22	Major: quartz; tr: talc, kaolinite
AUB-174	Major: quartz; tr: montmorillonite
AVB-48	Major: quartz, talc; minor: sepiolite

relied on their care in controlling the parameters that influenced the quality of the data. DOGAMI's primary quality-control role was to determine, by examination of the data, if the capability of the XRF method was realized. This assessment was based on replicate analyses of samples and analyses of standard reference limestones.

Because of the limited number of observations (n, n=2 or 3) for a given constituent in a given sample, statistical calculations were not warranted. However, qualitative statements of precision and accuracy can be made.

1. For precision, an estimate of standard deviation can be obtained from the range of observations and the mean (see XRAL's statements of precision).

Example: Sample AUB-20, CaO = 44.0, 44.4, 44.6; range = 44.0 to 44.6, mean = 44.3; by observation, the CaO values lie within ±0.3 of the mean; compare with standard deviation of 0.31.

2. Comparison of the XRF value of a constituent with a wet chemical value—an instrumental method vs. a more accurate method—can be used as a measure of accuracy.

Example: Sample AUB-20, CaO determined by wet chemical methods was 44.04; compare with mean of XRF values, 44.3.

3. Comparison of the XRF value of a constituent in a standard reference limestone (submitted as a sample) with the certified value for that standard can be used as a measure of accuracy.

Examples:

Standard identity	XRF value CaO		Certified value CaO
BCS-368 dolomite	30.5	vs.	30.8
NBS-1c arg. limestone	50.2	vs.	50.3

4. Comparison of the values of a constituent obtained by two independent instrumental methods can be used as a measure of accuracy, but it is less reliable.

Example: Sample AUB-20, compare directly coupled plasma (DCP) emission spectrometry value for SiO_2 of 2.10 with XRF value of 3.01 (average).

5. The total of the constituents, Sum, if considered as a constituent itself, is an indicator of accuracy, although it is not always reliable. Where the individual constituents (1)

Table 24. *Gold content of "high silica" limestone (in parts per billion).*

Lab no.	Au	Lab no.	Au	Lab no.	Au	Lab no.	Au
AUB-44	<1	AUB-89	<1	AVB-24	7	AVB-102	4
AUB-47	3	AUB-94	<1	AVB-32	3	AVB-103	6
AUB-49	<1	AUB-96	6	AVB-39	3	AVB-104	15
AUB-57	<1	AUB-99	<1	AVB-40	1	AVB-105	3
AUB-59	2	AUB-139	<1	AVB-70	3	AVB-108	2
AUB-71	<1	AUB-140	<1	AVB-83	3	AVB-109	6
AUB-80	<1	AUB-149	<1	AVB-98	4	AVB-110	10
AUB-81	6	AUB-152	<1	AVB-99	3	AVB-111	4
AUB-83	<1	AUB-161	<1	AVB-100	8	AVB-112	3
AUB-85	<1	*Composite	<1	AVB-101	3		

*AUB-141 through -144

Table 25. *Replicate analyses of selected limestone samples.*[1]

Laboratory note[2]	Sample no.	CaO[3]	MgO[3]	SiO_2	Al_2O_3	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	Sum
XRF	AUB-3	56.6	0.52	0.20	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.04	42.9	100.3
XRF blind replicate	AUB-3	56.6	0.38	0.20	<0.01	0.01	0.01	<0.01	<0.01	0.01	0.04	42.6	99.0
XRF Cr steel	AUB-3	56.9	0.43	0.17	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.04	42.8	100.4
XRF	AUB-10	55.1	0.48	0.18	0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	44.0	100.2
XRF replicate	AUB-10	56.0	0.41	0.19	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.02	43.2	99.8
DCP	AUB-10	(53.52)	0.32	0.62	0.14	0.01	0.02	0.03	<0.01	<0.01	0.04	43.20	97.90
Wet chemistry	AUB-10	55.79	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-20	44.0	9.79	3.03	0.14	<0.01	0.04	0.03	<0.01	0.02	0.16	43.2	100.4
XRF replicate	AUB-20	44.4	9.90	3.08	0.15	<0.01	0.03	0.03	<0.01	0.02	0.16	42.0	99.8
XRF blind	AUB-20	44.6	10.0	2.91	0.15	<0.01	0.03	0.04	<0.01	0.02	0.16	41.5	99.4
DCP	AUB-20	(46.64)	(8.43)	2.10	0.26	0.02	0.05	0.09	0.01	<0.01	0.18	43.30	101.08
Wet chemistry	AUB-20	44.04	9.10	--	--	--	--	--	--	--	--	--	--
XRF	AUB-30	54.0	0.87	1.78	0.08	<0.01	0.01	0.04	<0.01	0.01	0.08	43.3	100.2
XRF replicate	AUB-30	54.6	0.83	1.87	0.10	<0.01	0.02	0.05	<0.01	0.01	0.08	41.5	99.1
DCP	AUB-30	(51.67)	0.71	2.34	0.16	0.01	0.03	0.09	0.01	<0.01	0.12	42.80	97.94
Wet chemistry	AUB-30	54.37	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-40	48.5	0.42	11.8	0.61	0.02	0.09	0.38	0.01	0.04	0.08	38.4	100.4
XRF replicate	AUB-40	48.7	0.43	11.9	0.63	0.01	0.08	0.36	0.01	0.04	0.08	37.8	100.2
DCP	AUB-40	(48.55)	0.41	10.37	0.72	0.10	0.11	0.44	0.03	0.04	0.08	37.80	98.64
Wet chemistry	AUB-40	48.43	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-50	49.0	0.44	9.36	0.96	0.08	0.16	0.61	0.08	0.05	0.09	39.2	100.1
XRF replicate	AUB-50	49.2	0.46	9.43	0.98	0.07	0.15	0.63	0.08	0.06	0.09	38.6	99.8
DCP	AUB-50	(46.87)	0.44	8.02	1.07	0.17	0.12	0.70	0.11	0.06	0.13	38.90	96.65
Wet chemistry	AUB-50	49.50	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-60	48.2	0.40	11.6	0.63	<0.01	0.06	0.59	0.03	0.03	0.09	38.4	100.1
XRF replicate	AUB-60	48.4	0.42	11.8	0.63	<0.01	0.06	0.54	0.03	0.03	0.09	38.0	100.1
DCP	AUB-60	(48.75)	0.40	11.16	0.74	0.03	0.06	0.60	0.06	0.03	0.05	38.20	100.12
Wet chemistry	AUB-60	48.67	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-70	55.2	0.21	1.15	0.01	<0.01	0.01	0.16	<0.01	0.01	0.03	43.5	100.3
XRF replicate	AUB-70	55.7	0.22	1.17	0.02	<0.01	0.01	0.16	<0.01	0.01	0.03	42.5	99.9
DCP	AUB-70	(52.72)	0.20	1.20	0.13	<0.01	<0.01	0.22	0.01	<0.01	<0.01	43.00	97.48
Wet chemistry	AUB-70	55.31	--	--	--	--	--	--	--	--	--	--	--

XRF	AUB-71	12.1	3.59	46.2	14.1	2.13	1.33	8.17	0.10	0.91	0.23	10.8	99.8
DCP	AUB-71	(11.17)	3.67	46.45	14.67	2.52	1.45	8.76	0.11	1.00	0.28	10.60	100.69
Wet chemistry	AUB-71	11.51	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-80	31.6	1.55	27.0	7.07	0.88	0.73	3.70	0.04	0.41	0.17	24.9	98.2
XRF replicate	AUB-80	32.0	1.51	27.2	7.08	0.89	0.71	3.65	0.05	0.40	0.17	24.5	98.3
DCP	AUB-80	(31.03)	1.43	26.02	7.35	1.24	0.78	3.81	0.06	0.47	0.22	26.00	98.41
Wet chemistry	AUB-80	31.34	1.49	--	--	--	--	--	--	--	--	--	--
XRF	AUB-81	13.3	1.53	51.1	10.1	1.43	0.91	5.08	0.05	0.57	0.45	12.1	96.8
DCP	AUB-81	(11.82)	1.42	52.21	9.95	1.65	0.96	5.15	0.05	0.61	0.50	12.60	96.91
Wet chemistry	AUB-81	12.93	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-90	54.8	0.45	1.28	0.02	<0.01	0.01	0.04	<0.01	0.01	0.06	43.5	100.3
XRF replicate	AUB-90	55.2	0.47	1.35	0.03	<0.01	0.01	0.03	<0.01	0.01	0.06	42.6	99.9
DCP	AUB-90	(55.03)	0.42	0.95	0.14	0.04	<0.01	0.07	0.01	<0.01	0.06	43.00	99.72
Wet chemistry	AUB-90	54.84	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-100	54.0	0.63	1.52	0.23	<0.01	0.01	0.16	0.01	0.02	0.05	43.4	100.1
XRF replicate	AUB-100	54.5	0.59	1.64	0.26	<0.01	0.02	0.12	0.01	0.02	0.05	42.7	100.0
DCP	AUB-100	(52.61)	0.48	1.48	0.36	0.03	0.03	0.23	0.04	0.02	0.07	43.10	98.44
Wet chemistry	AUB-100	54.36	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-110	53.7	1.46	0.67	0.02	0.02	0.01	0.04	0.04	0.01	0.03	44.1	100.1
XRF replicate	AUB-110	54.4	1.42	0.69	0.03	0.01	0.01	0.03	0.04	0.01	0.03	43.0	99.7
DCP	AUB-110	(56.42)	1.06	1.04	0.04	<0.01	0.01	0.08	0.06	<0.01	0.04	43.40	102.15
Wet chemistry	AUB-110	54.36	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-120	51.0	3.90	0.83	0.27	<0.01	0.04	0.12	<0.01	0.02	0.02	43.7	100.0
XRF replicate	AUB-120	51.4	3.88	0.88	0.28	<0.01	0.06	0.13	<0.01	0.02	0.02	43.1	99.8
DCP	AUB-120	(54.20)	2.76	1.15	0.05	<0.01	0.07	0.13	0.01	0.01	0.05	43.40	101.83
Wet chemistry	AUB-120	51.63	3.72	--	--	--	--	--	--	--	--	--	--
XRF	AUB-130	55.7	0.63	0.28	0.09	<0.01	0.01	0.04	<0.01	0.01	0.03	43.7	100.5
XRF replicate	AUB-130	56.0	0.52	0.30	0.10	<0.01	0.01	0.04	<0.01	0.02	0.03	43.0	100.0
XRF blind rep.	AUB-130	56.4	0.52	0.27	0.11	<0.01	0.01	0.04	<0.01	0.02	0.03	42.9	100.3
DCP	AUB-130	(56.23)	0.50	0.44	0.09	<0.01	<0.01	0.16	0.01	0.02	0.04	43.40	100.89
Wet chemistry	AUB-130	55.94	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-140	37.8	3.74	26.4	0.56	0.03	0.08	0.32	0.03	0.07	0.07	31.2	100.4
XRF replicate	AUB-140	37.6	3.74	26.6	0.57	0.02	0.09	0.38	0.03	0.06	0.07	30.9	100.1
DCP	AUB-140	(34.52)	3.40	28.01	0.65	0.07	0.09	0.45	0.05	0.05	0.05	35.10	102.44
Wet chemistry	AUB-140	37.93	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-143	30.4	18.3	20.6	<0.01	0.02	0.01	0.03	<0.01	0.02	0.06	30.8	100.3
DCP	AUB-143	(27.73)	(16.74)	21.40	0.09	0.02	<0.01	0.06	0.01	<0.01	0.10	33.20	99.34
Wet chemistry	AUB-143	26.43	17.77	--	--	--	--	--	--	--	--	--	--

Laboratory note[2]	Sample no.	CaO[3]	MgO[3]	SiO_2	Al_2O_3	Na_2O	K_2O	Fe_2O_3	MnO	TiO_2	P_2O_5	LOI	Sum
XRF	AUB-144	25.8	13.5	46.7	<0.01	0.02	0.01	0.08	<0.01	0.02	0.06	14.1	100.3
XRF blind rep.	AUB-144	26.0	13.8	47.1	0.01	<0.01	0.01	0.08	<0.01	0.02	0.06	13.5	100.6
XRF blind rep.	AUB-144	25.9	13.9	47.1	0.01	<0.01	0.01	0.07	<0.01	0.02	0.06	13.50	100.6
XRF Cr steel	AUB-144	--	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-150	53.9	0.47	2.04	0.45	0.02	0.04	0.46	0.03	0.09	0.06	42.8	100.5
XRF replicate	AUB-150	54.1	0.40	2.06	0.45	0.01	0.04	0.48	0.03	0.09	0.06	42.2	99.9
DCP	AUB-150	(56.36)	0.26	1.55	0.06	<0.01	0.06	0.46	0.05	0.10	0.08	42.30	101.27
Wet chemistry	AUB-150	54.13	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-160	37.0	1.99	20.3	4.00	0.36	0.33	4.45	0.05	0.70	0.13	31.1	100.5
XRF replicate	AUB-160	37.1	1.95	20.5	4.00	0.34	0.34	4.38	0.05	0.70	0.13	31.0	100.6
DCP	AUB-160	(32.84)	1.82	21.95	4.07	0.47	0.31	4.78	0.07	0.80	0.13	31.30	98.54
Wet chemistry	AUB-160	35.97	--	--	--	--	--	--	--	--	--	--	--
XRF	AUB-165	42.1	12.5	0.56	0.23	0.03	0.06	0.07	<0.01	0.02	0.04	44.8	100.4
XRF blind rep.	AUB-165	42.6	12.7	0.58	0.24	<0.01	0.07	0.07	<0.01	0.03	0.04	43.0	99.4
XRF	AUB-170	55.9	0.40	0.32	0.09	<0.01	0.01	0.01	<0.01	0.01	0.03	43.5	100.4
XRF replicate	AUB-170	56.2	0.33	0.33	0.09	<0.01	0.02	0.01	<0.01	0.01	0.03	43.0	100.1
DCP	AUB-170	(53.11)	0.30	2.41	0.21	0.02	0.02	0.03	<0.01	<0.01	0.03	43.60	99.73
Wet chemistry	AUB-170	55.55	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-1	51.9	4.03	0.41	0.03	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.1	99.6
XRF replicate	AVB-1	51.7	4.06	0.40	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.2	99.5
XRF	AVB-10	50.8	2.54	4.52	0.06	<0.01	0.03	<0.01	<0.01	<0.01	0.06	41.5	99.4
XRF replicate	AVB-10	51.0	2.56	4.50	0.08	<0.01	0.03	<0.01	<0.01	<0.01	0.06	41.4	99.7
DCP	AVB-10	--	0.67	3.49	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.05	42.20	--
Wet chemistry	AVB-10	51.10	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-20	51.7	4.10	0.38	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.0	99.3
XRF replicate	AVB-20	51.9	4.12	0.39	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.0	99.5
DCP	AVB-20	--	(3.47)	0.45	0.07	<0.01	0.04	<0.01	<0.01	<0.01	0.02	44.00	--
Wet chemistry	AVB-20	51.32	4.10	--	--	--	--	--	--	--	--	--	--
XRF	AVB-22	55.7	0.52	0.26	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	43.0	99.6
DCP	AVB-22	--	0.52	0.14	0.04	0.01	0.04	<0.01	<0.01	<0.01	<0.01	43.50	--
Wet chemistry	AVB-22	55.32	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-30	36.0	17.5	1.86	0.26	<0.01	0.02	0.19	0.05	0.02	0.04	44.5	100.5
XRF replicate	AVB-30	35.8	17.6	1.90	0.27	<0.01	0.02	0.16	0.05	0.02	0.04	44.4	100.3
DCP	AVB-30	--	(14.32)	1.50	0.31	0.01	0.05	0.21	0.06	0.02	0.02	48.40	--
Wet chemistry	AVB-30	36.48	16.42	--	--	--	--	--	--	--	--	--	--

XRF	AVB-40	30.1	18.5	26.1	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.10	25.5	100.3
XRF replicate	AVB-40	30.0	18.6	26.2	<0.01	<0.01	0.02	0.02	<0.01	<0.01	0.10	25.5	100.5
DCP	AVB-40	--	(16.78)	26.65	0.03	0.01	0.05	0.04	<0.01	<0.01	0.06	25.30	--
Wet chemistry	AVB-40	21.95	18.50	--	--	--	--	--	--	--	--	--	--
XRF	AVB-43	50.9	1.06	6.79	0.38	<0.01	0.09	0.43	<0.01	0.04	0.02	40.6	100.4
XRF replicate	AVB-43	51.4	1.06	6.67	0.35	<0.01	0.09	0.45	<0.01	0.03	0.02	40.1	100.3
DCP	AVB-43	--	1.26	6.87	0.39	0.02	0.14	0.40	0.02	0.05	<0.01	40.70	--
Wet chemistry	AVB-43	50.80	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-47	55.1	0.62	0.56	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	42.1	98.5
DCP	AVB-47	--	0.32	0.46	0.01	0.07	0.05	0.03	0.02	<0.01	0.05	43.10	--
Wet chemistry	AVB-47	55.27	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-48	55.4	0.55	0.08	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	42.4	98.5
DCP	AVB-48	--	0.26	<0.01	0.02	0.01	0.05	<0.01	0.01	<0.01	<0.01	43.50	--
Wet chemistry	AVB-48	55.60	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-63	53.2	1.54	1.70	0.49	<0.01	0.19	0.12	<0.01	0.02	0.03	42.3	99.7
XRF replicate	AVB-63	53.5	1.47	1.67	0.48	<0.01	0.17	0.12	<0.01	0.01	0.03	42.5	99.8
DCP	AVB-63	--	1.07	1.49	0.53	0.02	0.28	0.20	<0.01	0.02	<0.01	42.60	--
Wet chemistry	AVB-63	53.30	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-83	53.1	0.65	1.15	0.22	<0.01	0.03	0.03	0.03	<0.01	0.02	42.8	98.7
XRF replicate	AVB-83	52.8	0.68	1.16	0.22	<0.01	0.03	0.09	0.03	0.01	0.02	42.5	98.3
DCP	AVB-83	--	0.38	0.96	0.28	0.03	0.09	0.07	0.05	0.02	<0.01	42.70	--
Wet chemistry	AVB-83	53.57	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-85	55.4	0.57	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	43.0	99.4
DCP	AVB-85	--	0.26	0.19	0.04	0.01	0.06	<0.01	0.01	<0.01	<0.01	43.40	--
Wet chemistry	AVB-85	55.66	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-86	55.5	0.51	0.31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	43.0	99.4
DCP	AVB-86	--	0.20	0.21	0.04	0.01	0.06	<0.01	<0.01	<0.01	<0.01	43.20	--
Wet chemistry	AVB-86	55.17	--	--	--	--	--	--	--	--	--	--	--
XRF	AVB-103	26.6	8.61	21.9	8.21	1.48	0.83	2.74	0.08	0.35	0.37	28.8	100.2
XRF replicate	AVB-103	26.6	8.56	21.6	8.24	1.52	0.85	2.66	0.08	0.34	0.36	29.2	100.2
DCP	AVB-103	--	(7.27)	21.87	8.03	1.51	0.97	2.43	0.08	0.34	0.27	29.40	--
Wet chemistry	AVB-103	25.16	8.95	--	--	--	--	--	--	--	--	--	--

1 Replicate XRF analyses for the trace elements were obtained. These data are available on request.

2 XRF = XRF analyses for oxides by XRAL.
DCP = DCP analyses by Bondar-Clegg.
Wet chemistry = Wet chemical analyses for CaO and MgO by Bondar-Clegg.
XRF blind replicate = Sample resubmitted to XRAL as a renumbered (blind) sample.
XRF replicate = XRAL's analysis of separate portion of the sample.
XRF Cr steel = Sample ground in steel media for comparison with sample ground in agate media, submitted as blind samples.

3 Details of Bondar-Clegg's analytical methods are available on request. Bondar-Clegg stated that the determination of CaO at high concentrations and MgO over 4 percent by DCP are not reliable. (These unreliable results are in parentheses in this table.) The wet-chemical analyses for CaO and MgO are considered to have higher accuracy than the XRF method employed by XRAL.

Table 26. *XRAL's analyses of limestone standards.**

Standard	CaO (%)	MgO (%)	SiO_2 (%)	Al_2O_3 (%)	Na_2O (%)	K_2O (%)	Fe_2O_3 (%)	MnO (%)	TiO_2 (%)	P_2O (%)	LOI (%)	Sr (ppm)	Sum (%)
BSC 368	30.5	21.1	1.12	0.14	0.02	0.02	0.27	0.04	0.02	0.01	46.6	70	99.9
	30.8	20.9	0.92	0.17	--	--	0.23	0.06	<0.01	--	46.7	67	--
BCS 372	66.1	1.6	20.7	5.34	0.10	0.64	2.68	0.03	0.25	0.19	2.08	950	99.8
	65.8	1.3	21.3	5.35	0.21	0.62	2.49	0.05	0.33	0.19	--	(1,400)	--
BCS 393	56.6	0.17	0.98	0.12	<0.01	<0.01	0.02	<0.01	<0.01	0.02	42.5	130	100.4
	55.4	0.15	0.70	0.12	(0.02)	0.02	0.045	0.010	0.009	(0.005)	43.4	160	--
IRSID 701-1	53.2	0.64	2.31	0.61	<0.01	0.06	0.98	0.01	0.03	0.06	42.1	240	100.0
	52.69	0.60	1.99	0.55	--	--	1.04	0.028	0.030	0.050	--	--	--
NBS 1c	50.2	0.43	7.20	1.29	0.01	0.28	0.55	0.01	0.07	0.05	39.8	220	99.9
	50.3	0.42	6.84	1.30	0.02	0.28	0.55	0.025	0.07	0.04	39.9	250	--
Composite	37.3	14.2	3.41	0.54	<0.01	0.11	0.21	0.04	0.04	0.03	44.1	140	100.0
	37.3	14.1	2.89	0.55	<0.01	0.09	0.34	0.05	0.02	0.04	44.4	128	--

*For each standard, the upper row of data gives XRAL's analyses; the lower row gives the certified values. These standards are internationally recognized standard reference materials (SRMs) and have been well characterized chemically. The SRMs were submitted to XRAL as blind samples.

A dash indicates that the value is unavailable. Parentheses indicate that the value is for information only.

The composite standard consists of 1 part of NBS 1c and 2 parts of BCS 368.BCS = Bureau of Analyzed samples, England.
IRSID = Institut de Recherches de la Siderurgie Francaise, France.
NBS = National Bureau of Standards.

Table 27. *Replicate analyses for acid insoluble content.*

Sample no.	Percent isoluble XRAL	Bondar-Clegg
AUB-015	0.50	0.25
AUB-020	3.06	2.77
AUB-065	3.60	3.60
AUB-084	11.50	16.46
AUB-104	1.48	1.56
AUB-114	2.46	2.29
AUB-151	4.16	3.92
AUB-155	26.20*	1.22
AUB-160	1.60*	22.75
AVB-017	0.58	0.47
AVB-030	1.94	1.71
AVB-085	0.62	0.47
AVB-110	34.20	30.10
AVB-112	29.20	27.14

*Probable error in sample indentification during analysis. The SiO_2 content is fair indicator of acid insoluble content: AUB-155 has 1.12 percent SiO_2, and AUB-160 has 20.3 percent SiO_2. The data reported by XRAL for these two samples were probably reversed.

have been accurately determined (as measured in 2, 3, and/or 4, above) and (2) have all been accounted for, then a Sum of 100.0 indicates that the analysis as a whole is accurate. As a practical matter, a Sum between 99.5 and 100.5 was considered acceptable. A Sum under 99.5, where (1) is true, indicates the presence of a constituent not analyzed for. A Sum over 100.5 likely reflects errors in one or more constituents. See Tables 25, 26, and 27 for quality-control data related to the chemical analyses.

Brightness

To measure precision, a replicate reading on a separate sample portion was made on every tenth sample. As indicated above, the precision was poor to good and was likely sample dependent. For the reasons given, high accuracy was not expected.

Gold analysis

No precision or accuracy tests were made.

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Special Paper 19

Limestone Deposits in Oregon
By Howard C. Brooks

Plate 1

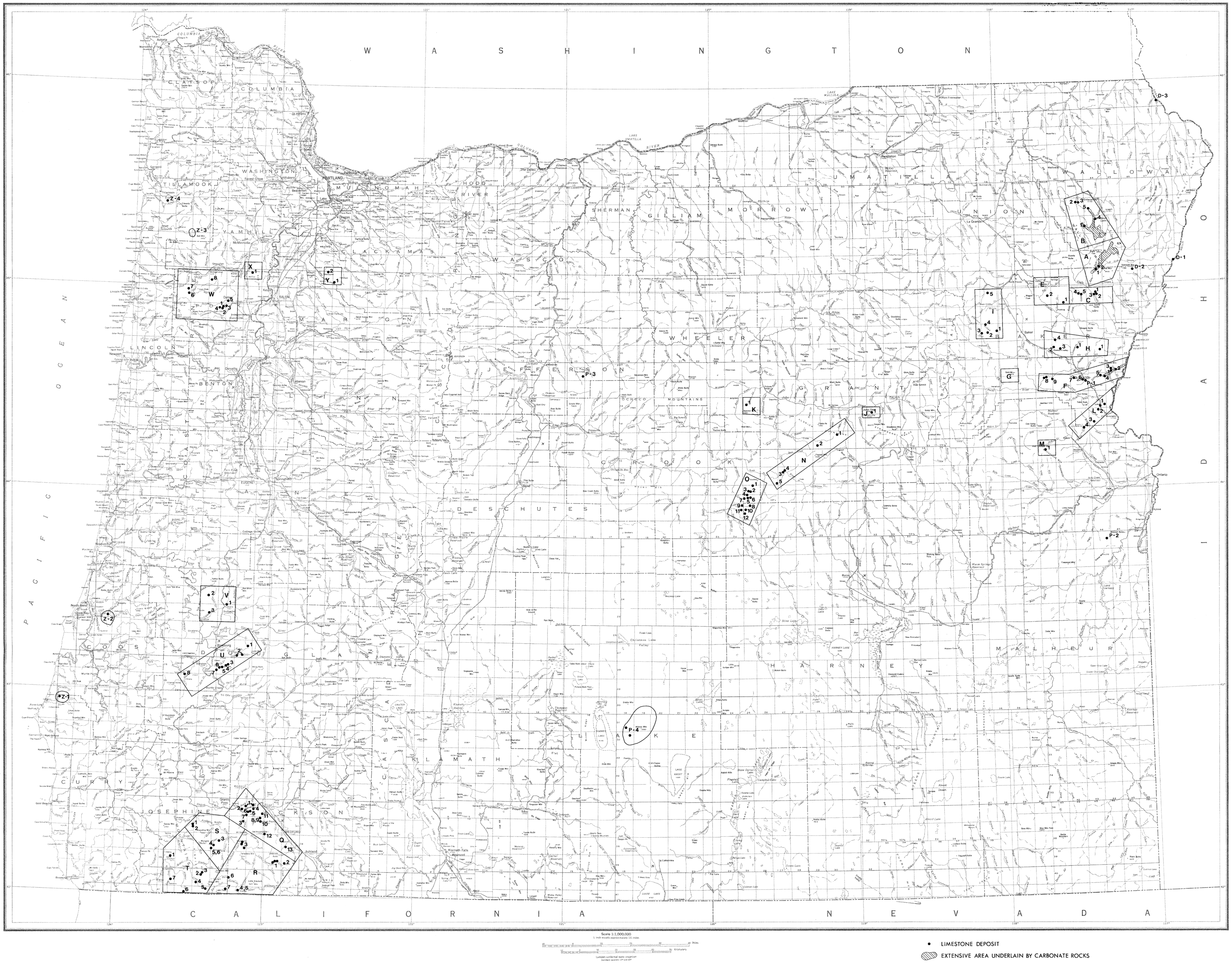
Table 1. *Locations and analytical data for AUB and AVB series of Oregon limestone samples collected and analyzed for this report.*

Locality no.	Sample no.	Terrane	Area	Deposit	Quadrangle	County	Location Sec.	T.	R.	Formation	$CaCO_3$* (wt.%)	$MgCO_3$** (wt.%)	CaO (wt.%)	MgO (wt.%)	SiO_2 (wt.%)	Al_2O_3 (wt.%)	Na_2O (wt.%)	K_2O (wt.%)	Fe_2O_3 (wt.%)	MnO (wt.%)	TiO_2 (wt.%)	P_2O_5 (wt.%)	LOI (wt.%)	SUM (wt.%)	Acid insol. (wt.%)	Cr (ppm)	Rb (ppm)	Sr (ppm)	Y (ppm)	Zr (ppm)	Nb (ppm)	Ba (ppm)	Brightness
NORTHERN WALLOWAS																																	
A-1	AUB-72	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	3	6 S.	44 E.	Martin Bridge Limestone	95.7	0.8	53.6	0.36	0.59	0.12	<0.01	0.03	0.06	<0.01	0.01	0.05	45.2	100.0	--	<10	<10	380	<10	<10	10	<10	71
A-1	AUB-73	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	3	6 S.	44 E.	Martin Bridge Limestone	97.1	1.1	54.4	0.53	0.50	0.13	<0.01	0.02	0.07	<0.01	0.01	0.06	44.2	100.1	--	<10	<10	380	<10	<10	10	<10	76
A-1	AUB-74	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	3	6 S.	44 E.	Martin Bridge Limestone	96.9	1.0	54.3	0.50	0.57	0.18	<0.01	0.03	0.07	<0.01	0.02	0.05	44.6	100.4	0.70	<10	<10	380	<10	<10	10	<10	62
A-1	AUB-75	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	27	6 S.	44 E.	Martin Bridge Limestone	96.7	1.0	54.2	0.47	0.57	0.16	<0.01	0.03	0.05	<0.01	0.01	0.03	44.8	100.3	--	<10	10	400	<10	<10	<10	<10	71
A-1	AUB-76	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	3	6 S.	44 E.	Martin Bridge Limestone	96.2	2.7	53.9	1.27	0.48	0.09	<0.01	0.02	0.04	<0.01	0.02	0.03	44.5	100.4	--	<10	<10	380	<10	<10	20	<10	71
A-1	AUB-77	Wallowa	East Eagle Creek	The Box	Eagle Cap 15'	Baker	3	6 S.	44 E.	Martin Bridge Limestone	97.6	1.2	54.7	0.59	0.66	0.18	<0.01	0.03	0.09	<0.01	0.02	0.04	43.9	100.3	--	<10	<10	490	<10	<10	10	160	70
A-2	AUB-114	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	94.8	2.6	53.1	1.23	2.12	0.84	0.04	0.12	0.33	<0.01	0.04	0.04	42.2	100.1	2.46	<10	<10	490	<10	<10	10	20	64
A-2	AUB-115	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	92.3	6.9	51.7	3.31	0.95	0.29	0.04	0.04	0.12	<0.01	0.02	0.04	43.6	100.2	--	<10	<10	530	<10	<10	10	10	63
A-2	AUB-116	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	96.0	3.7	53.8	1.77	0.81	0.27	0.03	0.03	0.11	<0.01	0.02	0.04	43.3	100.4	--	<10	<10	530	10	<10	10	10	60
A-2	AUB-117	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	96.0	3.6	53.8	1.73	0.62	0.15	0.01	0.03	0.06	<0.01	0.01	0.03	43.7	100.2	--	<10	10	540	<10	<10	20	20	59
A-2	AUB-118	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	90.5	8.5	50.7	4.08	1.00	0.31	0.06	0.06	0.12	<0.01	0.02	0.02	43.5	100.0	--	<10	10	590	<10	<10	<10	50	79
A-2	AUB-119	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	89.4	9.4	50.1	4.51	1.11	0.36	<0.01	0.10	0.14	<0.01	0.02	0.03	43.6	100.1	--	<10	<10	870	10	<10	10	30	74
A-2	AUB-120	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	91.0	8.2	51.0	3.90	0.83	0.27	<0.01	0.04	0.12	<0.01	0.02	0.02	43.7	100.0	--	<10	10	790	<10	<10	10	20	72
A-2	AUB-121	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	91.7	7.9	51.4	3.76	0.71	0.17	0.01	0.05	0.01	<0.01	0.02	0.02	44.2	100.4	--	<10	20	820	<10	<10	10	10	73
A-2	AUB-122	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	86.2	13.0	48.3	6.21	1.01	0.37	0.01	0.06	0.14	<0.01	0.02	0.02	44.2	100.5	--	<10	20	740	<10	<10	<10	30	66
A-2	AUB-123	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	95.3	3.8	53.4	1.80	0.96	0.25	<0.01	0.06	0.07	<0.01	0.02	0.03	43.4	100.1	--	<10	<10	1,230	<10	<10	10	30	68
A-2	AUB-124	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	94.6	4.7	53.0	2.24	0.90	0.20	<0.01	0.06	0.10	<0.01	0.02	0.02	43.5	100.3	1.22	<10	20	2,450	<10	<10	<10	20	71
A-2	AUB-125	Wallowa	East Eagle Creek	Curtis Creek	Eagle Cap 15'	Baker	35	5 S.	44 E.	Martin Bridge Limestone	92.4	6.5	51.8	3.12	1.06	0.26	0.01	0.04	0.06	<0.01	0.02	0.03	43.9	100.5	--	<10	<10	1,670	<10	<10	10	30	67
B-1	AVB-49	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	74.4	24.5	41.7	11.70	2.76	0.77	<0.01	0.13	0.41	<0.01	0.04	0.03	41.2	98.8	--	<10	<10	495	<10	<10	13	38	80
B-1	AVB-50	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	77.3	20.1	43.3	9.64	3.21	1.04	0.01	0.18	0.58	<0.01	0.04	0.04	40.9	99.0	--	<10	<10	482	14	<10	16	14	68
B-1	AVB-51	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	88.9	10.2	49.8	4.90	1.07	0.20	<0.01	0.12	0.07	<0.01	<0.01	0.02	42.2	98.5	--	<10	<10	728	<10	<10	<10	14	73
B-1	AVB-52	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	88.9	10.4	49.8	4.96	1.41	0.38	<0.01	0.13	0.51	<0.01	<0.01	0.03	42.0	99.3	2.44	<10	<10	596	<10	<10	11	37	66
B-1	AVB-53	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	90.7	9.5	50.8	4.55	0.70	0.09	<0.01	0.04	0.03	<0.01	<0.01	0.02	42.2	98.5	--	<10	16	470	<10	<10	<10	47	79
B-1	AVB-54	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	90.7	8.4	50.8	4.03	0.86	0.20	<0.01	0.10	0.09	<0.01	<0.01	0.03	42.2	98.4	--	<10	<10	637	<10	<10	10	13	81
B-1	AVB-55	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	94.4	7.0	52.9	3.37	1.11	0.26	<0.01	0.06	0.08	<0.01	<0.01	0.03	42.3	100.2	--	<10	<10	385	<10	<10	<10	10	78
B-1	AVB-56	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	89.1	11.6	49.9	5.54	1.05	0.28	<0.01	<0.01	0.07	<0.01	<0.01	0.06	41.7	98.6	--	<10	14	354	<10	<10	<10	<10	85
B-1	AVB-57	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	97.4	2.7	54.6	1.29	0.63	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	0.05	41.8	98.5	--	<10	10	342	<10	<10	<10	<10	86
B-1	AVB-58	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	96.0	2.3	53.8	1.08	1.71	0.48	<0.01	0.05	0.21	<0.01	0.01	0.03	41.4	98.8	--	<10	13	484	<10	<10	<10	<10	76
B-1	AVB-59	Wallowa	Lostine River	Marble Point	Enterprise 15'	Wallowa	24	3 S.	43 E.	Martin Bridge Limestone	94.0	4.1	52.7	1.95	1.25	0.32	<0.01	0.06	0.07	<0.01	<0.01	0.03	42.2	98.6	--	<10	<10	496	<10	<10	<10	40	83
B-2	AVB-60	Wallowa	Lostine River	Lower Lostine	Enterprise 15'	Wallowa	10	2 S.	43 E.	Martin Bridge Limestone	74.4	19.0	41.7	9.08	5.37	1.68	0.03	0.22	0.68	<0.01	0.07	0.03	39.5	98.4	--	<10	12	608	<10	<10	13	68	77
B-2	AVB-61	Wallowa	Lostine River	Lower Lostine	Enterprise 15'	Wallowa	10	2 S.	43 E.	Martin Bridge Limestone	93.0	4.3	52.1	2.05	3.05	0.95	0.01	0.37	0.23	<0.01	0.03	0.03	41.3	100.2	--	<10	<10	690	17	<10	<10	<10	78
B-2	AVB-62	Wallowa	Lostine River	Lower Lostine	Enterprise 15'	Wallowa	10	2 S.	43 E.	Martin Bridge Limestone	82.1	15.7	46.0	7.49	2.28	0.73	<0.01	0.45	0.32	<0.01	0.02	0.03	42.2	99.6	3.80	<10	<10	635	<10	<10	10	37	75
B-2	AVB-63	Wallowa	Lostine River	Lower Lostine	Enterprise 15'	Wallowa	10	2 S.	43 E.	Martin Bridge Limestone	94.9	3.2	53.2	1.54	1.70	0.49	<0.01	0.19	0.12	<0.01	0.02	0.03	42.3	99.7	--	<10	12	647	<10	<10	10	47	73
B-2	AVB-64	Wallowa	Lostine River	Lower Lostine	Enterprise 15'	Wallowa	9	2 S.	43 E.	Martin Bridge Limestone	95.8	1.7	53.7	0.79	0.83	0.13	<0.01	0.07	0.03	<0.01	<0.01	0.03	43.2	98.9	--	<10	16	825	<10	<10	<10	<10	69
B-5	AVB-77	Wallowa	Lostine River	Black Marble	Enterprise 15'	Wallowa	19,20	2 S.	44 E.	Martin Bridge Limestone	95.5	2.8	53.5	1.35	1.21	0.20	<0.01	0.03	0.07	<0.01	<0.01	0.02	43.0	99.5	--	<10	<10	1,170	<10	<10	11	15	17
B-5	AVB-78	Wallowa	Lostine River	Black Marble	Enterprise 15'	Wallowa	19,20	2 S.	44 E.	Martin Bridge Limestone	96.0	2.2	53.8	1.07	1.30	0.08	<0.01	0.02	0.07	<0.01	<0.01	0.02	43.2	99.7	1.30	<10	<10	1,190	<10	<10	<10	<10	21
B-5	AVB-79	Wallowa	Lostine River	Black Marble	Enterprise 15'	Wallowa	19,20	2 S.	44 E.	Martin Bridge Limestone	94.9	2.3	53.2	1.08	0.75	0.15	<0.01	0.04	0.04	<0.01	<0.01	0.02	43.5	98.9	--	<10	15	1,310	<10	<10	<10	43	19
SOUTHERN WALLOWAS																																	
C-1	AUB-64	Wallowa	Southern Wallowas	Paddy Creek	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	95.1	0.9	53.3	0.44	2.76	0.34	<0.01	0.01	0.17	<0.01	0.02	0.09	42.8	100.0	--	<10	10	420	10	<10	10	10	45
C-1	AUB-65	Wallowa	Southern Wallowas	Paddy Creek	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	94.6	0.8	53.0	0.40	3.51	0.15	<0.01	0.01	0.16	<0.01	0.01	0.06	43.0	100.4	3.60	<10	20	610	<10	<10	10	10	52
C-1	AUB-66	Wallowa	Southern Wallowas	Paddy Creek	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	93.3	1.0	52.3	0.48	5.13	0.32	<0.01	0.01	0.14	<0.01	0.02	0.06	41.7	100.2	--	<10	20	510	<10	<10	30	10	50
C-1	AUB-67	Wallowa	Southern Wallowas	Paddy Creek	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	94.0	1.1	52.7	0.52	3.92	0.32	<0.01	0.02	0.22	<0.01	0.02	0.07	42.3	100.2	--	<10	20	590	<10	<10	<10	20	45
C-1	AUB-68	Wallowa	Southern Wallowas	Paddy Creek	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	97.3	1.0	54.5	0.47	1.70	0.09	<0.01	0.01	0.04	<0.01	0.01	0.07	43.2	100.1	--	<10	<10	460	<10	<10	10	10	50
C-2	AUB-70	Wallowa	Southern Wallowas	Locality 278	Sparta 15'	Baker	15	7 S.	44 E.	Martin Bridge Limestone	98.5	0.4	55.2	0.21	1.15	0.01	<0.01	0.01	0.16	<0.01	0.01	0.03	43.5	100.3	--	<10	<10	360	<10	<10	10	10	66
C-3	AUB-78	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	77.5	1.3	43.4	0.63	16.6	3.00	0.33	0.33	1.36	0.03	0.13	0.11	34.3	100.3	--	<10	20	750	10	<10	10	100	36
C-3	AUB-79	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	73.2	2.6	41.0	1.26	17.4	4.08	0.39	0.45	2.32	0.05	0.22	0.09	33.0	100.4	--	<10	20	770	10	<10	<10	120	40
C-3	AUB-80	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	56.4	3.2	31.6	1.55	27.0	7.07	0.88	0.73	3.70	0.04	0.41	0.17	24.9	98.2	--	20	20	980	<10	10	20	210	25
C-3	AUB-81	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	23.7	3.2	13.3	1.53	51.1	10.1	1.43	0.91	5.08	0.05	0.57	0.45	12.1	96.8	--	120	30	1,080	10	30	20	360	18
C-3	AUB-82	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	78.2	1.6	43.8	0.75	16.1	2.61	0.37	0.20	1.36	0.03	0.13	0.18	34.6	100.3	--	<10	10	870	10	<10	10	160	32
C-3	AUB-83	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	73.2	1.5	41.0	0.74	19.7	3.56	0.56	0.25	1.53	0.03	0.15	0.11	32.7	100.5	--	<10	20	1,030	20	<10	10	100	34
C-3	AUB-84	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	79.8	1.3	44.7	0.62	15.2	2.16	0.25	0.20	0.93	0.02	0.10	0.11	35.8	100.2	11.5	<10	20	780	20	<10	10	90	37
C-3	AUB-85	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	46.9	2.9	26.3	1.37	39.2	7.73	1.18	0.67	2.28	0.05	0.27	0.14	20.8	100.2	--	20	40	1,160	30	10	10	300	37
C-3	AUB-86	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	94.9	0.9	53.2	0.45	3.74	0.17	<0.01	0.01	0.06	<0.01	0.02	0.06	42.5	100.3	--	<10	<10	900	<10	<10	<10	20	47
C-3	AUB-87	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	96.9	1.8	54.3	0.84	1.82	0.06	<0.01	0.01	0.05	0.01	0.01	0.04	43.4	100.2	--	<10	10	640	<10	<10	20	20	60
C-3	AUB-88	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	96.9	0.9	54.3	0.42	1.85	0.15	<0.01	0.01	0.09	0.01	0.02	0.06	43.5	100.5	--	<10	10	660	<10	<10	10	10	59
C-3	AUB-89	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	98.2	0.9	55.0	0.41	0.76	0.07	<0.01	0.01	0.03	<0.01	0.01	0.06	43.8	100.3	--	<10	10	850	<10	<10	10	10	49
C-3	AUB-90	Wallowa	Southern Wallowas	Martin's Bridge	Sparta 15'	Baker	21	7 S.	44 E.	Martin Bridge Limestone	97.8	0.9	54.8	0.45	1.28	0.02	<0.01	0.01	0.04	<0.01	0.01	0.06	43.5	100.3	--	<10	10	1,010	10	<10	10	20	47
C-4	AUB-60	Wallowa	Southern Wallowas	Larkspur Creek	Sparta 15'	Baker	16	7 S.	43 E.	Martin Bridge Limestone	86.0	0.8	48.2	0.40	11.6	0.63	<0.01	0.06	0.59	0.03	0.03	0.09	38.4	100.1	--	<10	20	830	<10	<10	<10	50	46
C-5	AUB-61	Wallowa	Southern Wallowas	Larkspur Creek 2	Sparta 15'	Baker	15	7 S.	43 E.	Martin Bridge Limestone	96.9	0.7	54.3	0.33	1.27	0.13	<0.01	0.01	0.08	<0.01	0.01	0.04	44.1	100.3	--	<10	10	230	<10	<10	20	20	64
C-5	AUB-62	Wallowa	Southern Wallowas	Larkspur Creek 2	Sparta 15'	Baker	15	7 S.	43 E.	Martin Bridge Limestone	94.2	0.5	52.8	0.23	4.13	<0.01	<0.01	0.01	0.07	<0.01	0.01	0.03	43.0	100.3	--	<10	<10	270	10	<10	20	20	63
C-5	AUB-63	Wallowa	Southern Wallowas	Larkspur Creek 2	Sparta 15'	Baker	15	7 S.	43 E.	Martin Bridge Limestone	97.8	0.6	54.8	0.30	0.78	0.05	<0.01	0.01	0.12	<0.01	0.01	0.03	43.7	99.8	--	<10	<10	230	<10	<10	<10	10	54
SNAKE RIVER CANYON AREA																																	
D-1	AVB-113	Wallowa	Snake River canyon	Big Bar limestone	Cuprum 15'	Wallowa	7,16	5 S.	49 E.	Martin Bridge Limestone	94.0	1.8	52.7	0.84	2.08	0.58	0.03	0.11	0.37	0.03	0.03	0.06	42.2	99.1	--	<10	13	509	12	<10	<10	23	47
D-1	AVB-114	Wallowa	Snake River canyon	Big Bar limestone	Cuprum 15'	Wallowa	7,16	5 S.	49 E.	Martin Bridge Limestone	65.0	32.2	36.4	15.40	1.62	0.37	0.02	0.13	0.20	0.06	0.03	0.11	44.4	98.8	--	<10	<10	108	<10	<10	<10	<10	59
D-1	AVB-115	Wallowa	Snake River canyon	Big Bar limestone	Cuprum 15'	Wallowa	7,16	5 S.	49 E.	Martin Bridge Limestone	94.8	1.9	53.1	0.89	1.77	0.43	<0.01	0.08	0.24	0.01	0.02	0.05	43.9	99.6	--	<10	<10	537	11	<10	14	<10	47
KEATING-MEDICAL SPRINGS AREA																																	
E-1	AVB-97	Wallowa	Keating/Medical Spr.	Sec. 34 deposit	Sawtooth Ridge 7½'	Baker	34	7 S.	42 E.	Clover Cr. Greenstone	97.3	1.0	54.5	0.48	1.31	0.19	<0.01	0.03	0.14	0.07	<0.01	0.04	42.8	99.6	--	<10	<10	142	<10	<10	<10	<10	60
E-2	AVB-98	Wallowa	Keating/Medical Spr.	Sec. 23 deposit	Keating NW 7½'	Baker	23	7 S.	41 E.	Clover Cr. Greenstone	53.0	12.0	29.7	5.76	27.9	3.49	0.06	0.19	3.27	0.49	0.19	0.08	29.5	100.6	--	<10	<10	61	11	<10	<10	38	61
DURKEE-FOX CREEK AREA																																	
F-1	AUB-5	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	95.1	3.8	53.3	1.82	0.52	0.02	<0.01	0.01	0.02	<0.01	0.01	0.04	44.2	99.9	0.38	<10	10	150	<10	<10	10	30	79
F-1	AUB-6	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	97.8	1.5	54.8	0.71	0.59	0.04	<0.01	0.01	0.01	<0.01	0.01	0.03	44.0	100.2	--	<10	10	170	<10	<10	10	30	62
F-1	AUB-7	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	98.5	1.1	55.2	0.53	0.23	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.03	44.1	100.1	--	<10	10	16	<10	<10	10	30	72
F-1	AUB-8	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	98.7	1.2	55.3	0.59	0.16	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.03	44.2	100.3	--	<10	10	190	<10	<10	10	10	67
F-1	AUB-9	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	98.5	1.1	55.2	0.53	0.15	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.03	44.1	100.0	--	<10	<10	150	<10	<10	10	20	71
F-1	AUB-10	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	99.0	1.0	55.5	0.48	0.18	0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	44.0	100.2	--	<10	10	170	<10	<10	<10	10	74
F-1	AUB-11	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	96.5	2.9	54.1	1.40	0.26	0.02	<0.01	0.01	<0.01	<0.01	0.01	0.04	44.3	100.2	--	<10	10	150	<10	<10	10	30	61
F-1	AUB-12	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	93.0	6.8	52.1	3.24	0.31	0.04	<0.01	0.01	0.01	<0.01	0.01	0.05	44.6	100.4	--	<10	10	150	<10	<10	10	20	62
F-1	AUB-13	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	95.5	4.3	53.5	2.06	0.29	0.01	<0.01	0.01	0.01	<0.01	0.01	0.04	44.5	100.5	--	<10	<10	160	<10	<10	10	<10	61
F-1	AUB-14	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	97.1	4.7	54.4	2.26	0.56	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	42.8	100.1	--	<10	<10	190	<10	<10	<10	20	69
F-1	AUB-15	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	94.4	6.3	52.9	3.01	0.22	0.01	<0.01	0.01	0.02	<0.01	0.01	0.02	44.4	100.6	0.50	<10	<10	200	<10	<10	10	30	77
F-1	AUB-16	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	98.7	1.7	55.3	0.80	0.28	0.02	<0.01	0.01	<0.01	<0.01	0.01	0.03	44.0	100.5	--	<10	10	270	<10	<10	10	10	65
F-1	AUB-17	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	93.7	4.3	52.5	2.05	2.13	0.04	<0.01	0.01	0.01	<0.01	0.01	0.05	43.5	100.2	--	<10	20	240	<10	<10	<10	20	66
F-1	AUB-18	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	91.5	7.4	51.3	3.52	1.79	0.03	<0.01	0.01	0.02	<0.01	0.02	0.04	43.8	100.6	--	<10	10	180	<10	<10	10	40	70
F-1	AUB-19	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	92.8	7.4	52.0	3.52	0.34	0.04	<0.01	0.01	0.02	<0.01	0.01	0.03	44.5	100.5	--	<10	<10	180	<10	<10	10	40	69
F-1	AUB-20	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	78.5	20.5	44.0	9.79	3.03	0.14	<0.01	0.04	0.03	<0.01	0.02	0.16	43.2	100.4	3.06	<10	10	200	<10	<10	10	50	61
F-1	AUB-21	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	82.1	16.7	46.0	8.01	1.90	0.09	<0.01	0.01	0.03	<0.01	0.02	0.07	44.3	100.5	--	<10	10	250	<10	<10	20	30	63
F-1	AUB-22	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	83.5	16.1	46.8	7.68	1.56	0.05	<0.01	0.02	0.03	<0.01	0.02	0.06	43.8	100.1	--	<10	10	270	<10	<10	10	40	66
F-1	AUB-23	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	87.4	11.7	49.0	5.61	2.80	0.03	<0.01	0.01	0.02	<0.01	0.01	0.04	42.3	99.9	--	<10	<10	200	<10	<10	<10	30	68
F-1	AUB-24	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	87.4	13.0	49.0	6.20	0.48	0.03	<0.01	0.01	0.03	<0.01	0.01	0.03	44.7	100.5	--	<10	10	160	<10	<10	10	10	73
F-1	AUB-25	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	91.0	6.9	51.0	3.28	2.45	0.10	<0.01	0.01	0.05	<0.01	0.02	0.08	43.4	100.4	--	<10	<10	190	<10	<10	10	30	60
F-1	AUB-26	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	89.2	8.4	50.0	4.01	2.61	0.15	<0.01	0.01	0.08	<0.01	0.01	0.12	43.5	100.5	--	<10	20	130	<10	<10	10	20	59
F-1	AUB-27	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	81.6	15.9	45.7	7.62	3.50	0.08	<0.01	0.02	0.09	<0.01	0.02	0.08	42.6	99.7	--	<10	10	90	<10	<10	20	30	62
F-1	AUB-28	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	81.0	14.3	45.4	6.86	5.92	0.09	<0.01	0.02	0.09	<0.01	0.01	0.09	41.9	100.4	--	<10	<10	140	<10	<10	<10	40	58
F-1	AUB-29	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	89.4	1.4	50.1	0.69	9.39	0.10	<0.01	0.02	0.08	<0.01	0.02	0.14	39.7	100.2	--	<10	10	200	<10	<10	20	40	58
F-1	AUB-30	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	96.4	1.8	54.0	0.87	1.78	0.08	<0.01	0.01	0.04	<0.01	0.01	0.08	43.3	100.2	--	<10	<10	290	10	<10	10	10	64
F-1	AUB-31	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	99.9	1.1	56.0	0.51	0.33	0.04	<0.01	0.02	0.08	<0.01	0.01	0.04	43.3	100.4	--	<10	10	210	10	<10	10	20	82
F-1	AUB-32	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	99.6	0.9	55.8	0.44	0.16	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.02	44.0	100.5	--	<10	10	220	<10	<10	<10	20	89
F-1	AUB-53	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	99.0	0.3	55.5	0.15	0.48	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	43.9	100.1	--	<10	<10	190	<10	<10	10	20	73
F-1	AUB-54	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	98.7	0.5	55.3	0.24	0.46	0.02	<0.01	0.01	0.03	<0.01	0.01	0.02	43.9	100.0	0.36	<10	10	190	<10	<10	10	50	72
F-1	AUB-55	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	97.6	0.2	54.7	0.10	1.57	<0.01	<0.01	0.01	0.02	<0.01	0.01	0.02	43.6	100.1	--	<10	10	170	<10	<10	10	30	82
F-1	AUB-56	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	98.9	0.3	55.4	0.16	1.09	0.01	<0.01	0.01	0.01	<0.01	0.01	0.03	43.5	100.3	--	<10	10	190	<10	<10	10	40	71
F-1	AUB-69	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	3	11 S.	45 E.	Nelson Marble	92.4	7.2	51.8	3.46	0.28	0.04	<0.01	0.01	0.03	<0.01	0.01	0.03	44.2	99.9	--	<10	10	190	<10	<10	10	40	65
F-1	AVB-3	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	93.2	6.0	52.2	2.88	0.64	0.11	<0.01	0.02	0.02	<0.01	<0.01	0.09	42.9	98.9	--	<10	15	110	<10	<10	<10	34	83
F-1	AVB-4	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	89.1	9.7	49.9	4.62	0.88	0.20	<0.01	0.04	0.03	<0.01	<0.01	0.07	43.1	98.9	--	<10	14	166	<10	<10	<10	80	75
F-1	AVB-5	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	81.7	16.9	45.8	8.11	1.57	0.14	<0.01	0.04	0.03	<0.01	<0.01	0.10	43.1	98.9	--	<10	<10	256	<10	<10	11	39	66
F-1	AVB-6	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	93.7	7.1	52.5	3.39	0.84	0.19	<0.01	0.05	<0.01	<0.01	<0.01	0.09	43.2	100.3	--	<10	11	262	<10	<10	<10	75	75
F-1	AVB-7	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	87.4	13.8	49.0	6.59	0.75	0.22	0.02	0.05	0.01	<0.01	0.01	0.11	43.0	99.8	1.02	<10	<10	274	<10	<10	<10	93	64
F-1	AVB-8	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	96.2	5.3	53.9	2.54	0.48	0.04	<0.01	0.02	<0.01	<0.01	<0.01	0.13	42.8	99.9	--	<10	<10	263	<10	<10	12	42	74
F-1	AVB-9	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	88.5	12.7	49.6	6.06	0.31	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.08	43.2	99.3	--	<10	<10	198	<10	<10	<10	37	74
F-1	AVB-10	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	90.7	5.3	50.8	2.54	4.42	0.06	<0.01	0.03	<0.01	<0.01	<0.01	0.06	41.5	99.4	--	<10	<10	249	<10	<10	<10	51	68
F-1	AVB-11	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	96.4	3.7	54.0	1.79	0.87	0.05	<0.01	0.03	<0.01	<0.01	<0.01	0.09	42.4	99.3	--	<10	<10	192	<10	<10	<10	45	64
F-1	AVB-12	Baker	Durkee/Fox Creek	Ash Grove property	Mineral 15'	Baker	32	11 S.	45 E.	Nelson Marble	83.3	16.0	46.7	7.64	1.68	0.07	<0.01	0.03	<0.01	<0.01	<0.01	0.06	42.9	99.1	--	<10	<10	198	<10	<10	15	90	62
F-2	AUB-51	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	99.8	0.2	55.9	0.10	0.34	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.02	43.5	100.0	--	<10	<10	230	<10	<10	10	40	83
F-2	AUB-52	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	27	11 S.	45 E.	Nelson Marble	98.7	0.2	55.3	0.11	0.76	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.03	44.2	100.4	--	<10	10	210	10	<10	10	40	86
F-2	AVB-13	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	99.2	1.5	55.6	0.72	0.24	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.5	99.1	--	<10	<10	196	<10	<10	<10	<10	71
F-2	AVB-14	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	99.8	0.8	55.9	0.38	0.17	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.05	42.6	99.2	--	<10	<10	218	<10	<10	<10	38	70
F-2	AVB-15	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	99.0	0.7	55.5	0.33	0.18	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.9	99.0	--	<10	<10	192	<10	<10	<10	46	73
F-2	AVB-16	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	33	11 S.	45 E.	Nelson Marble	99.2	0.9	55.6	0.42	0.29	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.5	98.9	--	<10	<10	229	<10	<10	<10	61	70
F-2	AVB-17	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	99.2	0.5	55.6	0.26	0.46	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.8	99.2	0.58	<10	<10	190	<10	<10	18	18	79
F-2	AVB-18	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	99.6	0.5	55.8	0.23	0.49	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	42.5	99.1	--	<10	<10	186	<10	<10	<10	37	77
F-2	AVB-19	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	99.6	0.8	55.8	0.37	1.08	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	42.1	99.4	--	<10	<10	177	<10	<10	<10	26	78
F-2	AVB-20	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	92.3	8.6	51.7	4.10	0.38	0.02	<0.01	0.02	<0.01	<0.01	<0.01	0.04	43.0	99.3	--	<10	<10	215	<10	<10	16	43	69
F-2	AVB-21	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	85.7	15.4	48.0	7.36	0.47	0.04	<0.01	0.03	<0.01	<0.01	<0.01	0.04	43.5	99.5	--	<10	<10	188	<10	<10	<10	19	76
F-2	AVB-22	Baker	Durkee/Fox Creek	Buchart	Mineral 15'	Baker	28	11 S.	45 E.	Nelson Marble	99.4	1.1	55.7	0.52	0.26	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	43.0	99.6	--	<10	<10	159	<10	<10	<10	42	81
F-3	AUB-1	Baker	Durkee/Fox Creek	Upper Connor Creek	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	97.1	1.1	54.4	0.52	1.28	0.02	<0.01	0.01	0.09	<0.01	0.02	0.07	43.8	100.3	--	<10	10	210	10	<10	10	40	63
F-3	AUB-2	Baker	Durkee/Fox Creek	Upper Connor Creek	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	98.2	1.2	55.0	0.57	0.77	<0.01	<0.01	0.01	0.02	<0.01	0.01	0.10	43.8	100.3	--	<10	10	170	<10	<10	10	<10	69
F-3	AUB-3	Baker	Durkee/Fox Creek	Upper Connor Creek	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	101.0	1.1	56.6	0.52	0.20	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.04	42.9	100.3	0.14	<10	10	160	<10	<10	10	20	74
F-3	AUB-4	Baker	Durkee/Fox Creek	Upper Connor Creek	Mineral 15'	Baker	29	11 S.	45 E.	Nelson Marble	99.2	1.3	55.6	0.63	0.23	0.01	<0.01	0.01	<0.01	<0.01	0.01	0.08	43.9	100.5	--	<10	10	170	<10	<10	10	20	75
F-6	AVB-81	Baker	Durkee/Fox Creek	Durkee quarry	Mineral 15'	Baker	10	11 S.	43 E.	Nelson Marble	96.2	2.9	53.9	1.37	0.33	<0.01	<0.01	0.01	0.02	<0.01	<0.01	0.05	43.1	98.9	--	<10	12	200	10	<10	10	77	68
F-6	AVB-82	Baker	Durkee/Fox Creek	Durkee quarry	Mineral 15'	Baker	10	11 S.	43 E.	Nelson Marble	96.9	2.5	54.3	1.22	0.27	<0.01	<0.01	0.01	0.03	<0.01	<0.01	0.05	43.2	99.1	0.36	<10	<10	207	<10	<10	<10	29	66
F-7	AVB-86	Baker	Durkee/Fox Creek	Powell Creek	Mineral 15'	Baker	8	11 S.	43 E.	Nelson Marble	99.0	1.1	55.5	0.51	0.31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	43.0	99.4	--	<10	<10	284	<10	<10	<10	<10	88
F-7	AVB-87	Baker	Durkee/Fox Creek	Powell Creek	Mineral 15'	Baker	8	11 S.	43 E.	Nelson Marble	98.3	1.1	55.1	0.51	0.87	0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.10	42.6	99.2	0.90	<10	13	169	<10	<10	<10	37	65
F-8	AUB-91	Baker	Durkee/Fox Creek	French Gulch	French Gulch 7½'	Baker	3	12 S.	41 E.	Burnt River Schist	78.5	1.9	44.0	0.93	19.1	0.33	0.04	0.05	0.15	0.01	0.02	0.06	35.6	100.4	19.1	<10	10	350	<10	<10	10	80	64

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
DONALD A. HULL, STATE GEOLOGIST

Map of limestone deposits and areas in Oregon

Special Paper 19
Limestone Deposits in Oregon
By Howard C. Brooks
Plate 2



Northeastern Oregon, Blue Mountains Province

- Wallowa terrane deposits
  - Northern Wallowas
    - East Eagle Creek area (area A)
      - The Box . . . . (A-1)
      - Curtis Creek . . . . (A-2)
    - Lostine River and Hurricane Creek area (area B)
      - Marble Point . . . . (B-1)
      - Lower Lostine . . . . (B-2)
      - Starlite Mine . . . . (B-3)
      - Wallowa Cement and Lime Company property . (B-4)
      - Black Marble quarry . . . . (B-5)
  - Southern Wallowas (area C)
    - Paddy Creek . . . . (C-1)
    - Locality 278 . . . . (C-2)
    - Martin's Bridge . . . . (C-3)
    - Larkspur Creek . . . . (C-4)
    - Larkspur Creek 2 . . . . (C-5)
  - Snake River Canyon area (area D)
    - Big Bar limestone . . . . (D-1)
    - Twin Lakes . . . . (D-2)
    - Cherry Creek . . . . (D-3)
  - Keating-Medical Springs area (area E)
    - Sec. 34 . . . . (E-1)
    - Sec. 27 . . . . (E-2)
- Baker terrane deposits
  - Durkee-Fox Creek area (area F)
    - Ash Grove property . . . . (F-1)
    - Butchart property . . . . (F-2)
    - Upper Connor Creek . . . . (F-3)
    - Summit Creek . . . . (F-4)
    - Sisley Creek . . . . (F-5)
    - Durkee quarry . . . . (F-6)
    - Powell Creek . . . . (F-7)
    - French Gulch . . . . (F-8)
    - Campbell Gulch . . . . (F-9)
  - Bald Mountain area (area G)
  - Pleasant Valley-Virtue Hills area (area H)
    - Nodine Creek and Lawrence Creek . . . . (H-1)
    - Oxman 10 . . . . (H-2)
    - Oxman 13 . . . . (H-3)
    - Second Creek . . . . (H-4)
  - Elkhorn Ridge area (area I)
    - Marble Creek quarry . . . . (I-1)
    - Baboon Creek quarry . . . . (I-2)
    - Lake Creek . . . . (I-3)
    - Upper Pine Creek . . . . (I-4)
    - Bulger Hill . . . . (I-5)
  - John Day area (area J)
    - Dog Creek . . . . (J-1)
  - Dayville-Antone area (area K)
    - West Birch Creek . . . . (K-1)
- Olds Ferry terrane deposits
  - Lime area (area L)
    - Lime quarries . . . . (L-1)
    - Cavanaugh Creek . . . . (L-2)
    - Limestone Butte . . . . (L-3)
    - Phipps Creek . . . . (L-4)
  - Juniper Mountain area (area M)
- Izee terrane deposits
  - Izee-Suplee area (area N)
    - Ingle Rock . . . . (N-1)
    - Stewart Spring . . . . (N-2)
    - Cow Creek . . . . (N-3)
    - Pine Creek . . . . (N-4)
    - Harris Spring exposure . . . . (N-5)
- Grindstone terrane deposits
  - Grindstone-Twelvemile area (area O)
    - Grindstone 155 . . . . (O-1)
    - Trout Creek . . . . (O-2)
    - Grindstone 150 . . . . (O-3)
    - Grindstone 135 . . . . (O-4)
    - Grindstone 133 . . . . (O-5)
    - Grindstone 313 . . . . (O-6)
    - Coffee Creek limestone . . . . (O-7)
    - Williams Reservoir . . . . (O-8)
    - Twelvemile Reservoir . . . . (O-9)
    - Three Buttes . . . . (O-10)
    - Tuckers Butte . . . . (O-11)
    - Berger Ranch . . . . (O-12)

Isolated deposits and lacustrine limestone and travertine deposits in eastern Oregon (area P)

- Durkee travertine . . . . (P-1)
- Shell Rock Butte . . . . (P-2)
- Hay Creek Ranch . . . . (P-3)
- Tenmile Ridge . . . . (P-4)

Southwestern Oregon, Klamath Mountains Province

- Gold Hill-Talent area (area Q)
  - Beaver Portland Cement Company deposits . . . . . (Q-1)
  - Rogue River . . . . (Q-2)
  - Dole limestone . . . . (Q-3)
  - Galls Creek . . . . (Q-4)
  - Colvig Gulch . . . . (Q-5)
  - Bristol dolomite . . . . (Q-6)
  - Lyons Gulch (Bristol limestone) . . . . (Q-7)
  - Lively quarry . . . . (Q-8)
  - Baxter limestone . . . . (Q-9)
  - Beeman limestone . . . . (Q-10)
  - Millionaire limestone . . . . (Q-11)
  - Ensele quarry . . . . (Q-12)
  - Briner quarry . . . . (Q-13)
- Upper Applegate area (area R)
  - Bear Gulch . . . . (R-1)
  - Bald Mountain . . . . (R-2)
  - Applegate River group . . . . (R-3)
  - Seattle Bar . . . . (R-4)
  - Seattle Bar 2 . . . . (R-5)
  - Sturgis Fork . . . . (R-6)
  - Whiskey Peak . . . . (R-7)
- Marble Mountain And Williams Creek area (area S)
  - Marble Mountain quarry . . . . (S-1)
  - Muck quarry . . . . (S-2)
  - Horsehead marble quarry . . . . (S-3)
  - Turvey limestone . . . . (S-4)
  - Jones marble . . . . (S-5)
  - Last Chance group . . . . (S-6)
- Upper Illinois River area (area T)
  - Holton Creek . . . . (T-1)
  - Oregon Caves . . . . (T-2)
  - Morris . . . . (T-3)
  - Sucker Creek . . . . (T-4)
  - Swan Mountain . . . . (T-5)
  - West Fork Althouse Creek . . . . (T-6)
  - Elder Creek . . . . (T-7)
- Roseburg area (area U)
  - Buckhorn limestone . . . . (U-1)
  - Hatfield Ranch . . . . (U-2)
  - Dodson . . . . (U-3)
  - Julian Hatfield . . . . (U-4)
  - Harrington . . . . (U-5)
  - Oregon Portland Cement Company quarries . . . . . (U-6)
  - Fisher . . . . (U-7)
  - Byron limestone . . . . (U-8)
- Oakland area (area V)
  - Oakland . . . . (V-1)
  - Green Valley . . . . (V-2)
  - Starr Ranch . . . . (V-3)

Northwestern Oregon, Coast Range and Cascade Range

- Dallas area (area W)
  - Oregon Portland Cement Company quarry . . . . . . (W-1)
  - Lime Products Company quarry . . . . (W-2)
  - McBee . . . . (W-3)
  - Waymire Creek limestone beds . . . . (W-4)
  - Rickreall Creek . . . . (W-5)
  - Boulder Pass . . . . (W-6)
  - Rowell Creek . . . . (W-7)
  - Buell . . . . (W-8)
- Eola Hills area (area X)
  - Amity . . . . (X-1)
- Scotts Mills area (area Y)
  - Beaver Creek . . . . (Y-1)
  - Marquam . . . . (Y-2)

Isolated deposits in western Oregon (area Z)

- Unnamed . . . . (Z-1)
- Morgan limestone . . . . (Z-2)
- Nestucca River . . . . (Z-3)
- Faucet Creek . . . . (Z-4)