

Information Circular 8664

**Effects of Urbanization  
Upon the Availability of Construction  
Minerals in Southeastern Florida**

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# EFFECTS OF URBANIZATION UPON THE AVAILABILITY OF CONSTRUCTION MINERALS IN SOUTHEASTERN FLORIDA

by

Curtis D. Edgerton<sup>1</sup>

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## ABSTRACT

Miami Oölite limestone is the only significant construction mineral in southeastern Florida. Its source area coincides with that of rapid urban expansion. Two-thirds of the existing resource is already unavailable because of development. Land-use conflicts place future availability of limestone in jeopardy. However, a sufficient limestone resource to meet demand for many years is present if its extraction is not restricted. Adverse environmental effects of quarrying Miami Oölite are not severe; land values often increase following quarrying. Future availability depends upon--(1) achieving uniformity of Federal, State, county, and municipality statutory requirements governing quarry operations; (2) setting aside specific land areas for future quarrying; and (3) cooperative planning to provide for land utilization upon completion of quarrying.

## INTRODUCTION

The future availability of construction minerals in southeastern Florida requires study. Rapid urban growth and development conflict with extractive mineral operations. Once the surface of a site has been developed for urban use, any construction minerals at the site are lost to utilization.

In southeastern Florida, the only significant construction mineral is limestone of the Miami Oölite Formation. Its source area is delimited on the south and east by the Atlantic Ocean. Quarrying to the west is impeded by the Everglades. Northward, the Miami Oölite is not present. Thus, the source area of construction minerals in southeastern Florida coincides with an area in which rapid urban growth and development are taking place.

This valuable source of a needed mineral commodity is in jeopardy because of land-use conflicts. Zoning patterns and statutory requirements often restrict the development of new quarries and the extraction of minerals at presently operating quarries. A collision course is developing between industry efforts to supply needed construction minerals by expanding existing operations and opening new quarries, and the need for more land to accommodate urban sprawl.

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This study, requested by the Florida Bureau of Geology, has been made to assess future availability of construction minerals, to determine the impact of land-use conflicts upon this availability, and to suggest ways of minimizing such conflicts.

#### ACKNOWLEDGMENTS

The author is indebted to the many quarry operators, real estate developers, and personnel of Federal, State, county, and municipal governments who provided information used in preparing this report. Special acknowledgment is due the Broward County Area Planning Board, the Metropolitan Dade County Planning Advisory Board and Planning Department, and the Palm Beach County Planning, Zoning, and Building Department. In compiling land-use data the author has freely drawn upon reports from these agencies.

#### SOUTHEASTERN FLORIDA

The southeastern Florida study area of this report consists of the following three counties:

County:	<u>Area,</u> <u>square miles</u>	<u>Percent of</u> <u>study area</u>
Broward.....	1,219	23
Dade.....	2,042	39
Palm Beach.....	2,023	38
Southeastern Florida	<u>5,284</u>	<u>100</u>

County seats are, respectively, Fort Lauderdale, Miami, and West Palm Beach.

Salient statistics of economic activity, including the mineral industries in southeastern Florida from 1958 through 1967 are given in table 1. These statistics reveal a pattern of marked economic growth in southeastern Florida. Total retail sales increased 77 percent, while wholesale sales rose 88 percent. The average annual number of employees increased 94 percent. From 1960 to 1970, bank deposits increased 280 percent. This growth trend continued at similar levels through 1973.

TABLE 1. - Salient statistics of economic activity, including the mineral industries, in southeastern Florida

Economic activity	County						Southeastern Florida	
	Broward		Dade		Palm Beach		Florida	
	1958	1967	1958	1967	1958	1967	1958	1967
Mineral industries:								
Number of establishments.....	14	17	30	22	8	8	52	47
Number of employees.....	182	200	619	500	35	NA	836	NA
Payroll (millions).....	1.0	0.9	2.9	3.6	0.1	NA	4.0	NA
Value of shipments and receipts (millions).....	4.9	4.7	12.3	10.0	0.6	NA	17.8	NA
Civilian labor force, 16 years old and older (thousands).....	1118	2237	1360	2533	188	2136	1566	2906
Total bank deposits (millions)....	1364	21,170	11,104	22,825	1226	2742	11,694	24,737
Manufacturing:								
Average annual number of employees.....	6,172	15,800	36,528	58,300	3,420	15,400	46,120	89,500
Payroll (millions).....	25	95	140	303	14	107	179	505
Average annual wage.....	4,051	6,013	3,833	5,197	4,094	6,948	3,881	5,642
Total retail sales (millions).....	433	997	1,369	2,175	321	582	2,123	3,754
Total wholesale sales (millions)...	253	470	1,451	2,724	150	298	1,854	3,492

NA Not available.

<sup>1</sup>1960 data.

<sup>2</sup>June 1970 data.

Source: County and City Data Book, 1962 and 1972. U.S. Department of Commerce, Bureau of the Census.

From 1961 to 1970, the population of southeastern Florida increased from 1,593,700 to 2,263,100, or 42 percent (4-5),<sup>2</sup> whereas national population increased from 183,742,000 to 203,213,000 or 11 percent. Bureau of Mines projections indicate that by 1985 southeastern Florida may have a population of 3.5 million (table 2, fig. 1).<sup>3</sup>

TABLE 2. - Estimated population of southeastern Florida,<sup>1</sup> 1950-85

Year	County			Total
	Broward	Dade	Palm Beach	
1950	86,600	505,900	116,700	709,400
1955	170,900	713,100	169,500	1,053,300
1960	341,100	942,800	230,000	1,513,900
1965	465,900	1,108,800	295,000	1,869,700
1970	632,000	1,277,600	352,900	2,263,100
1975	750,806	1,513,156	410,154	2,674,116
1980	890,665	1,709,783	469,569	3,070,017
1985	1,030,524	1,906,409	528,984	3,465,917

<sup>1</sup>Includes Broward, Dade, and Palm Beach Counties.

<sup>2</sup>Projections by U.S. Bureau of Mines.

Source: Bureau of Economic and Business Research. Florida Statistical Abstract, 1967. University of Florida, College of Business Administration, March 1967, pp. 20-27; June 1971, pp. 29, 31, 32.

In southeastern Florida, local zoning commissions and county planning boards manage land utilization. Each board has provided for long-range land-use planning by issuing guidelines in the form of maps and reports. The accompanying land-use plan map (fig. 2) was constructed from data obtained from the boards. The map depicts a conceptual plan of density patterns to contain an ultimate population that could be adequately served by existing resources. No intent is implied that the density patterns are fixed entities; indeed, long-range planning of land use requires periodic update and revision to best serve the needs of the populace. The county planning boards recognize and strongly emphasize this. The map in this report is designed to show only a generalized plan of land utilization. Maps and reports of the county planning boards provide more detailed information (3, 10, 12).

<sup>2</sup>Underlined numbers in parentheses refer to items in the list of references at the end of this report.

<sup>3</sup>Projections of county populations through 1985 were obtained by fitting least squares through available population from 1950 through 1970. The linear equations used are--

$$\text{Broward County} \dots \dots \dots y = 530,023 + 39,325X$$

$$\text{Dade County} \dots \dots \dots y = 51,510 + 27,972X$$

$$\text{Palm Beach County} \dots \dots \dots y = 113,079 + 11,882X$$

where  $y$  = population

$X$  = time, beginning in 1950.

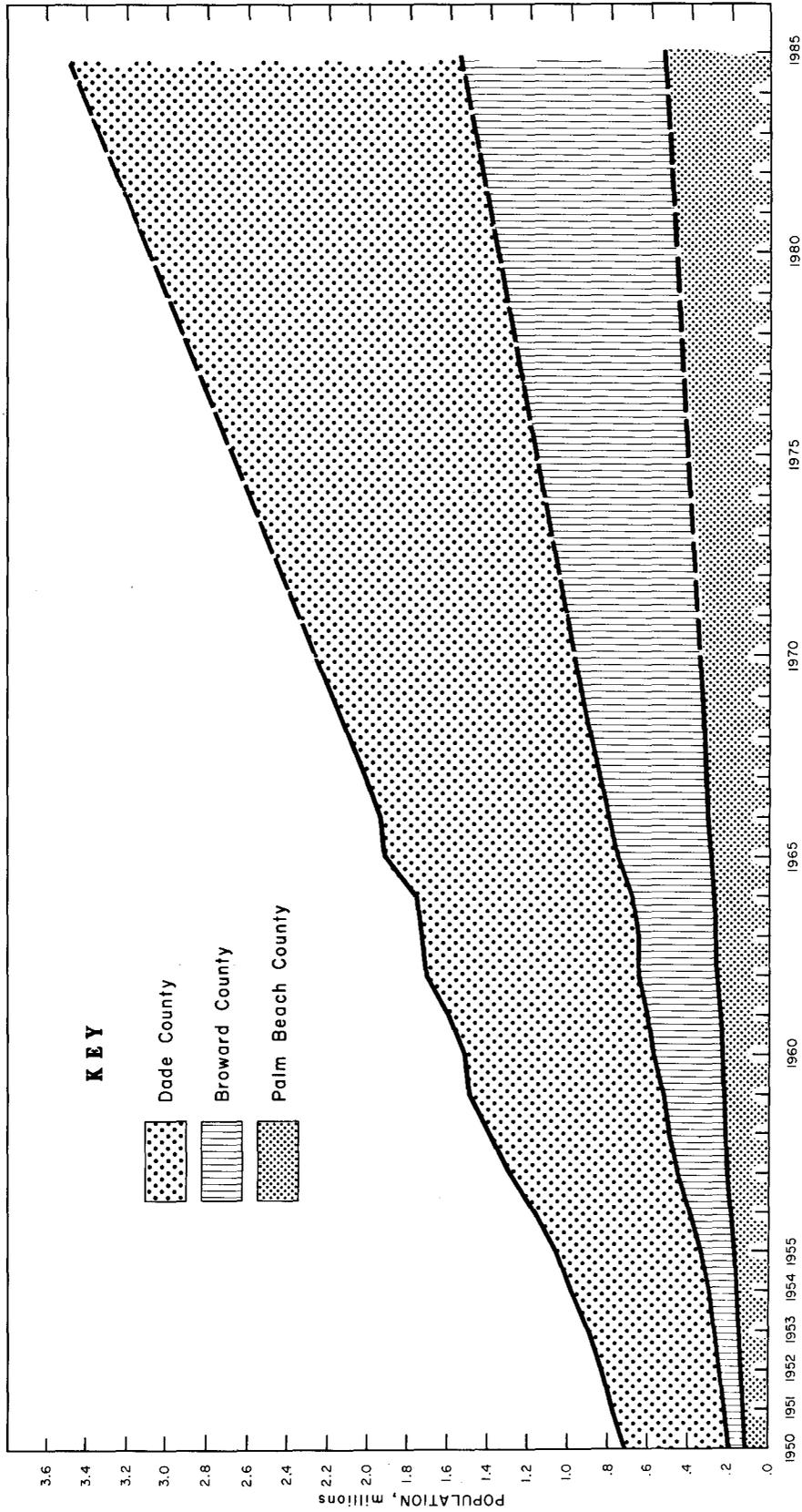


FIGURE 1. - Projected population, southeastern Florida.

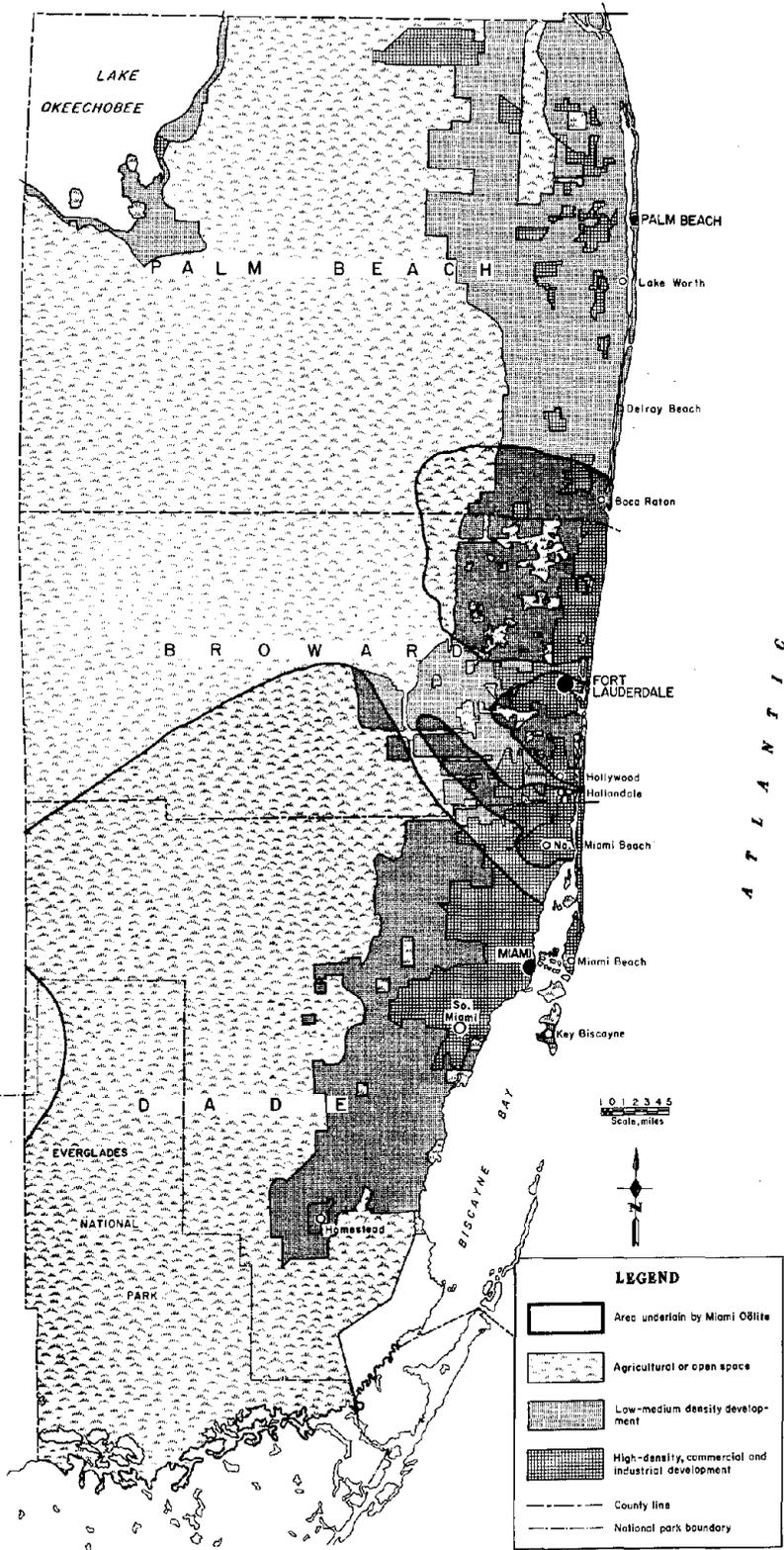


FIGURE 2. - Land-use plan map, southeastern Florida.

Table 3 shows a breakdown of planned land-use categories in southeastern Florida. To accommodate the residential, commercial, and industrial needs of an ultimate population would require approximately 1,133 square miles, or 21.4 percent of the total southeastern Florida area. The remainder of the area would be committed for agricultural purposes, or as open space.

RESOURCES

The term "construction minerals" in this report refers to nonmetallic minerals used by the construction industries for base material for roads and airport runways, aggregate, and in the manufacture of cement, brick, tile, and similar ceramic products. The only significant construction mineral within the area is limestone of the Miami Oolite Formation. Silica sand and oyster-shell are minor resources.

TABLE 3. - Planned land utilization in southeastern Florida<sup>1</sup>

County	Agricultural or open space		Low-medium density		High-density commercial, industrial	
	Square miles	Percent, total area	Square miles	Percent, total area	Square miles	Percent, total area
Broward.....	997	81.8	152	12.5	70	5.7
Dade.....	1,574	77.1	302	14.8	166	8.1
Palm Beach.....	1,580	78.1	392	19.4	51	2.5
Southeastern Florida....	4,151	78.6	846	16.0	287	5.4

<sup>1</sup>Data derived from references (3, 10, and 12).

#### Limestone

The total resource of limestone in southeastern Florida is sufficient to meet local demand for many years to come if its extraction is not restricted. Calculations based on a conservative average quarryable thickness of 40 feet, a weight of about 85 pounds per cubic foot, and a loss factor of 25 percent indicate a total resource of 102 billion tons. Two-thirds, or 68 billion tons, is estimated to be unavailable because of existing urban development and statutory limitations against extraction. The remaining 34 billion tons is available for quarrying under present conditions. Although only about 1 percent of the total tons available will be needed by 1985 (fig. 8), operators already are having difficulty in locating new quarry sites because of pressures brought to bear by environmentally concerned parties.

Miami Oölite (Pleistocene) is the only limestone presently being quarried in southeastern Florida for stone production. (In past years, a reef limestone known as the Key Largo was quarried in the southern part of the study area.)

Miami Oölite is found at, or very near, the surface in virtually all of Dade County and in most parts of Broward County except for the northwestern one-third, where the older Fort Thompson Formation is exposed (fig. 3). Where Miami Oölite is overlain by younger deposits, these deposits consist of organic muds and marls, predominately calcareous terrace and beach sands, and alluvial deposits seldom exceeding 5 feet in thickness. Calver (7) describes Miami Oölite as consisting of comparatively soft, white limestone composed of small spherical grains, or oörites, sand and shell fragments, and often containing solution holes and channels, which in some places have been filled with crystals of secondary calcite. Drill holes have revealed thicknesses ranging from 30 feet in the eastern part of Dade County to as much as 85 feet in the north-central Dade County and south-central Broward County.

Data indicate that the rock usually meets the generally required specification of abrasion resistance, which is not more than 40 percent loss in the Los Angeles abrasion test (1, 2); usually, it is of sufficiently high-carbonate content to be marketable. In northeastern Dade County and south-central Broward County, Miami Oölite approaches and in places exceeds the

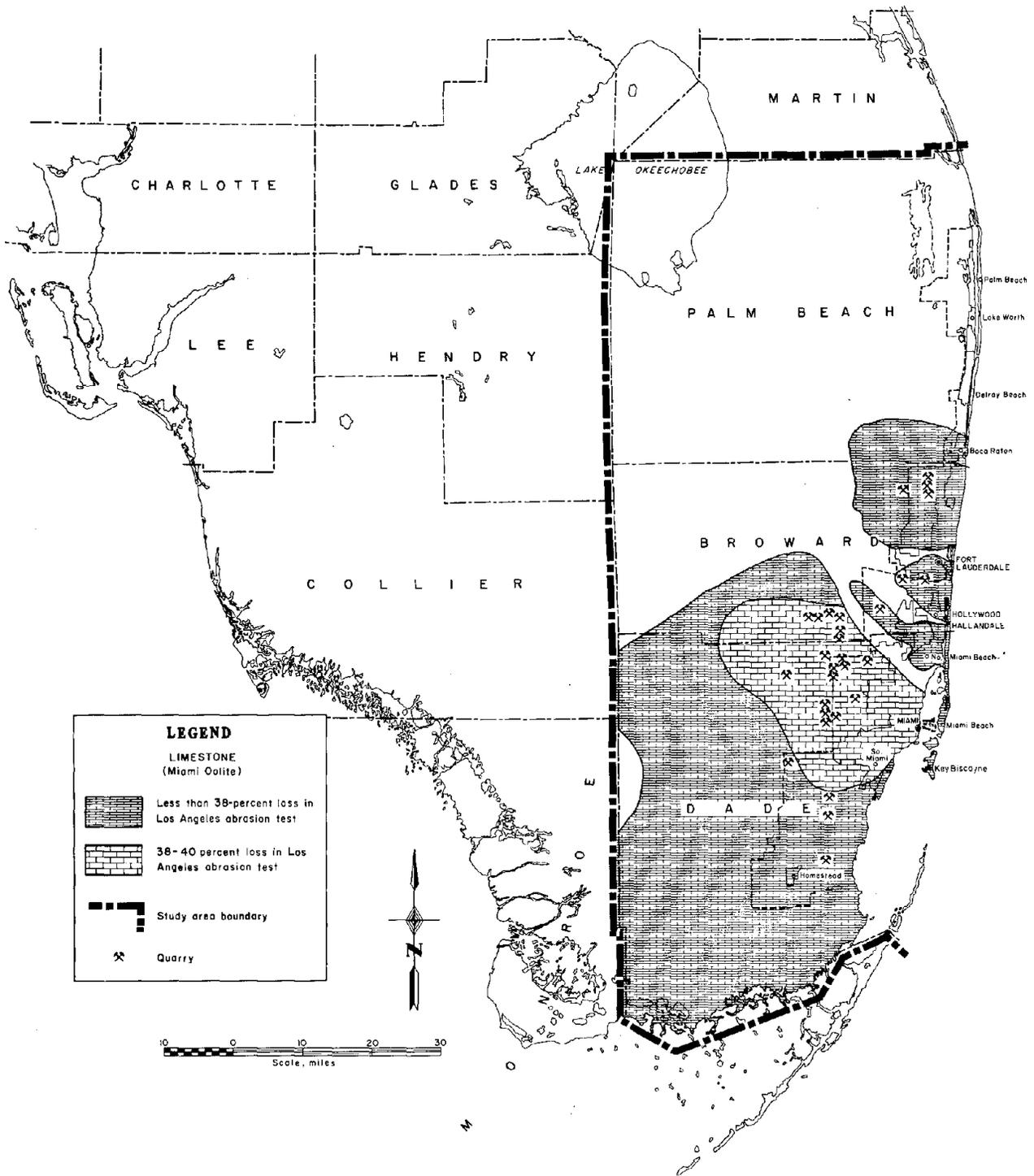


FIGURE 3. - Distribution of Miami Oolite in southeastern Florida.

40-percent loss limit. Elsewhere the abrasion resistance ranges downward into the lower 30 percent range (fig. 3).

Miami Oölite, in small particle sizes, is locally termed "sand". This is material that passes a 4-mesh screen and is retained on a 325-mesh screen. Material designated concrete screenings ranges in size from minus 4- to plus 100-mesh; asphalt screenings range from minus 4- to plus 325-mesh.

Most of the sand produced in southeastern Florida is the byproduct or coproduct of crushing operations at Miami Oölite quarries. Hence, the geology of this sand is analogous to that of the Miami Oölite.

#### Silica Sand

The resource of silica sand cannot be readily determined because of the erratic areal extent of deposits and because of the rapid horizontal and vertical changes in character of the material within the deposits. However, shortages of silica sand do exist in southeastern Florida as existing operations reach property boundaries and further expansion becomes impossible. These shortages can be expected to increase in severity.

The insignificant amount of silica sand produced in southeastern Florida comes from small terrace and alluvial deposits. These deposits were probably interfingering with calcareous material during deposition. Subsequent reworking has resulted in a heterogeneous mix of silica sand and fine-grained calcareous material; high-purity silica sand is thus a rarity.

#### Oystershell

The oystershell resource in southeastern Florida is virtually impossible to measure, but the total, compared with the limestone resource, is very small. Oystershell, like limestone, for all practical purposes is a non-renewable resource, and the few existing banks are becoming depleted. Statutory restrictions have brought dredging almost to a standstill in some areas. Indeed, in Palm Beach County, a moratorium in effect throughout most of 1972 prohibited all dredging operations. Oystershell has not been, nor will it be in the future, a significant commodity in the construction minerals industry in southeastern Florida.

#### DEMAND FOR MINERALS

Demand for construction minerals in southeastern Florida is revealed by production because quarry operators do not produce for stockpiling and there are almost no imports. Limestone constitutes the predominate demand item, and except for an occasional anomalous year, makes up more than 95 percent of the construction mineral demand. Total demand for limestone rose from 15 million tons in 1964 to 21.3 million tons in 1971. Salient statistics of construction minerals in southeastern Florida are given in table 4. A Bureau of Mines projection indicates that the demand for limestone may reach 33 million tons annually by 1985. Least squares projections also reveal that both actual value and value on a constant dollar basis (1967 = 100) are also increasing. These trends are illustrated in figure 4.

TABLE 4. - Salient statistics of limestone and sand and gravel in southeastern Florida, 1962-71

(Thousand short tons and thousand dollars)

Year	Limestone			Sand and gravel		
	Production	Total value	Value per ton	Production	Total value	Value per ton
1962	W	W	W	W	W	W
1963	W	W	W	1,607	\$884	\$0.55
1964	15,082	\$14,783	\$0.98	715	498	.70
1965	W	W	W	W	W	W
1966	15,255	16,016	1.05	W	W	W
1967	14,324	14,964	1.04	W	W	.96
1968	15,801	W	W	W	W	W
1969	19,333	W	W	W	W	W
1970	W	W	W	W	W	W
1971	21,268	30,238	1.42	W	W	W

W Withheld to avoid disclosure of individual company confidential data.

The decreasing order of demand in southeastern Florida for construction minerals is for aggregate and road base usage, for cement manufacture, and for the manufacture of brick, tile, and similar ceramic products.

#### LAND VALUES

In areas of rapid urban growth, land values experience rapid increases and are often driven upward even in excess of immediate worth. Excessive values are a result of speculation. Investors who have no developmental purposes in mind often buy large parcels of land to hold until sold later at a profit.

These parcels are thus removed from immediate usage. Values of other lands in the area increase as residential, commercial, industrial, and institutional developers compete for remaining land.

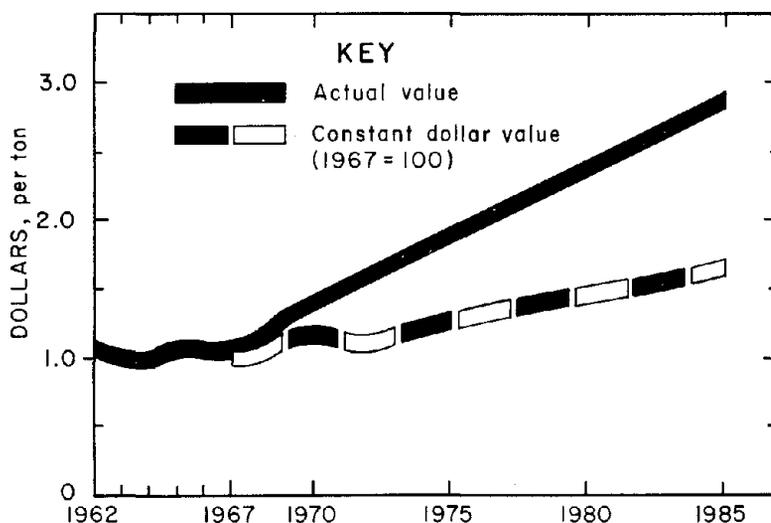


FIGURE 4. - Value of limestone in southeastern Florida, 1962-85.

The proximity of land to existing development has a direct bearing upon its value. In southeastern Florida, realtors report values ranging from a high of \$30,000 or more per acre for choice, low-density residential land, to a low of \$300 per acre for remote and inaccessible marsh lands. Reported values

for undeveloped land in outlying areas in Dade County zoned for several use categories are as follows:

Use:	<u>Value per acre</u>
Commercial.....	\$20,000-30,000
Industrial.....	13,500-30,000
Low-density residential.....	13,500-30,000
High-density residential.....	6,000-15,000
Agricultural.....	4,000- 6,000
Open space.....	300- 2,500

Although quarrying may damage land and depress land values, the contrary appears true in southeastern Florida. Because of the high water table, quarrying of Miami Oolite results in the formation of a lake with choice waterfront building sites. Numerous quarry lakes in the midst of congested housing and commercial development are shown in figure 5. In the left center of the photograph is an active quarry operation. Comparing the turbidity of the water in the active pit with that in the abandoned quarry lakes clearly shows the temporary nature of the turbidity. Housing developments sometimes commence in the vicinity of quarries before quarry operations are suspended.



FIGURE 5. - Quarry lakes in midst of congested housing and commercial development.

Quarry operators in southeastern Florida report paying as high as \$15,000 per acre for quarry land. The long-range effect of quarrying on land values is variable and generally beneficial. Upon completion of quarrying, land values of \$25,000 per gross acre are common.

Figures 6 and 7 show apartment complexes built adjacent to abandoned quarries.

#### LAND-USE CONFLICTS AND MINERAL SUPPLY

Urban expansion, such as southeastern Florida is experiencing, leads to land-use conflicts as various interests vie for land. Developers of housing, shopping centers, and industrial sites request zoning boards to set aside lands for their particular use. As a result, zoning restrictions are sometimes made without much thought as to sequential land usage that would permit land to serve more than a single purpose. Lands containing needed mineral commodities are commonly developed as housing, shopping, or industrial sites before minerals are extracted; the minerals must then be obtained at greater distance, and prices are driven upward. This is perhaps nowhere more evident than in the construction minerals industry where, in order to minimize costs, extraction of commodities should take place nearest the point of consumption.

In southeastern Florida, land to accommodate the expanding population is available only to the west of the heavily developed coast. Even to the west, the Everglades presents a barrier to expansion. Thus, much of the land available for development constitutes the source area from which construction minerals are now being extracted. Already quarry sites are being encroached upon. Statutory regulations are causing some operations to be restricted, and working hours and blasting operations are limited.

In the projection shown in figure 8, the sum of the yearly production figures indicates that from 1972 to 1985 a total of 364 million tons of limestone will be needed. Assuming that 55,539 tons per acre of limestone can be recovered by quarrying (based on a bulk density of 85 lb/cu ft, an average quarrying depth of 40 feet, and a loss factor of 25 percent), a total of 6,556 acres, or 10.2 square miles, will be required to yield the necessary limestone through 1985. In southeastern Florida, 69 percent, or 1,705 square miles, of land underlain by Miami Oölite has been designated by planning boards as agricultural or open space.

County	Total area underlain by Miami Oölite		Agricultural or open space underlain by Miami Oölite	
	Square miles	Percent	Square miles	Percent
Broward.....	462	38	203	20
Dade.....	1,932	95	1,471	93
Palm Beach.....	67	3	31	2
Southeastern Florida.	2,461	47	1,705	41

Only 0.6 percent of agricultural or open space land would be required for quarrying limestone. This land should be made available and set aside for the purpose of extracting construction minerals. Reserving land as future supply sources of construction minerals has, as of this date, not been done.



FIGURE 6. - Apartment complex adjoining abandoned quarry lake.



FIGURE 7. - Apartment complex adjoining abandoned quarry lake.

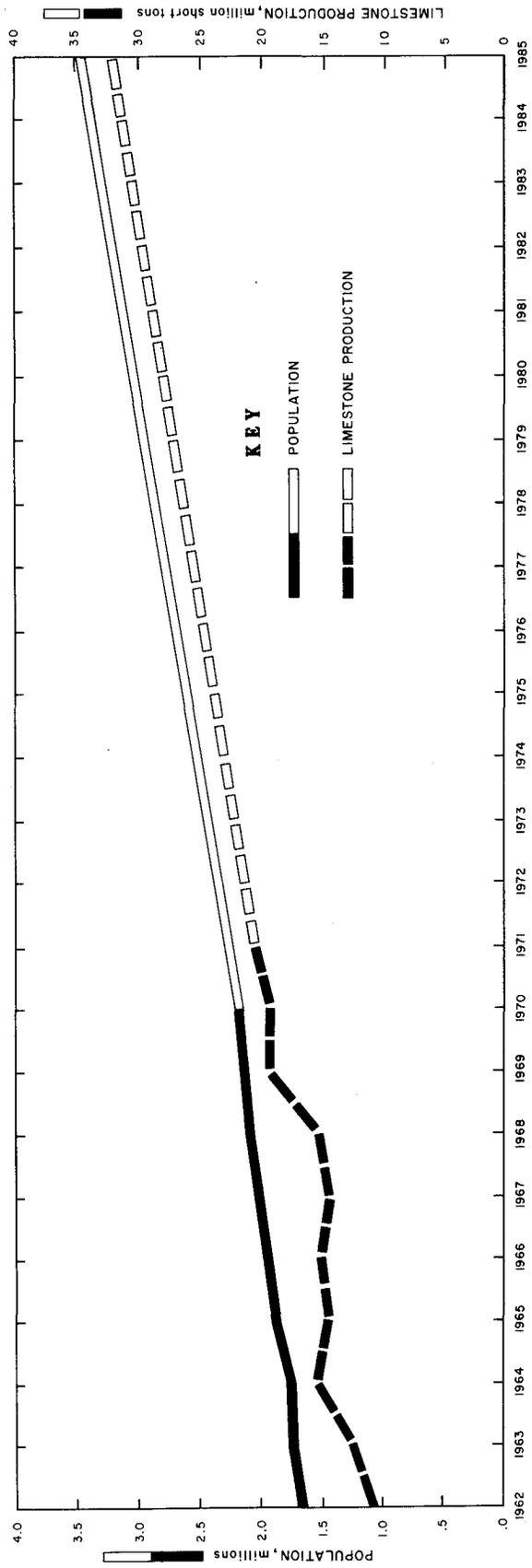


FIGURE 8. - Projected population and trend of limestone production, southeastern Florida, 1962-85.

In setting aside land for quarrying, distance to consuming points should be considered. Long haulages increase costs, which are inevitably passed on to the consumer. Even though lands set aside for quarrying may require long hauls of nearly equal distance, and thereby all quarry operators would be competitive in that respect, the consumer would bear the burden of these haulage costs. Haulage costs are an important factor in total costs to the consumer, and it is the total cost that must be kept low to prevent stagnation of vital sectors of the southeastern Florida economy.

#### CONCLUSIONS

Population and demand for crushed limestone in southeastern Florida are both increasing. Any restrictions imposed upon quarry operations that would limit production may disrupt population and corresponding economic growth; construction minerals at economic prices might not be available to accommodate the needs of a growing population.

Southeastern Florida holds a great reserve of limestone. A consistently reliable supply at economical prices can be assured. Three courses of action should be taken to provide for future supplies at economic prices.

First, uniformity of statutory requirements of the various Federal, State, county, and municipality governing bodies regulating quarrying should be achieved. This uniformity should apply to all phases of quarrying, from initial permits and bonding requirements to final stages of restoration. When quarry operators know precisely what is required of them, uncertainty is eliminated, efficient operational plans can be made, and lower costs should result.

Second, as land-use planners reserve specific areas for residential, industrial, institutional, and other used, specific areas for obtaining construction minerals should be set aside. Logical areas are lands that have been designated as agricultural or open space.

Third, cooperative planning among quarry operators and local governments should focus on ways to utilize land following mineral extraction. Sound sequential land-use plans formulated before minerals are removed, should enable quarry operators to plan operations efficiently with knowledge of what future reclamation costs to expect. The subsequent availability of quarried lands for public utilization would also be assured.

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## APPENDIX A.--QUARRYING METHODS

The first step in the startup of a quarry is the removal of overburden which, in southeastern Florida, consists of a few feet of soil and organic muck. Bulldozers are used to scrape the overburden from the underlying limestone, and to pile and compact the material around the perimeter of the quarry site. The actual quarrying of the limestone is hindered by a high water table, which is often encountered before the overburden is completely removed. The water is made turbid by particulate material churned up by quarrying. Operations thus cannot be observed. Consequently, it is impossible to achieve full efficiency in quarrying, and production costs are driven upward.

Blasting is done by emplacing explosive agents in holes bored in the limestone by conventional drill rigs. Because of the low-bearing pressure of the land surface, these rigs are usually track-mounted. Gelatinized dynamite packed in water-resistant casings is the explosive agent commonly employed, although a mixture of ammonium nitrate-fuel (AN-FO) is occasionally used. The high water table in southeastern Florida fostered the development by quarry operators of a specialized explosives loading technique called "kelly bar loading." In kelly bar loading, a hollow, metal tube follows the drill bit down as the hole is drilled. When the hole reaches total depth, the drill bit is withdrawn, leaving the kelly bar in place. The explosive cartridges are then lowered into the hole through the kelly bar, which is then withdrawn. The explosive is fired by detonating cord (13).

Blasting under water, as must be done in southeastern Florida quarries, does not pose insurmountable technical difficulties. However, because water readily transmits shock waves to the area surrounding the quarry, the operators must often employ less than adequate explosive charges to keep shock waves to acceptable levels. Operators generally monitor seismic levels induced by blasting, although this is not yet a statutory requirement. Recently, cease and desist orders have been directed against some operators. Although these orders were lifted, the result was that these operators subsequently confined blasting operations to periods as short as 1 hour per day. The efficient planning of quarry operations under these conditions is virtually impossible, especially when the working face is hidden from view, and the amount of available rock loosened by blasting is not known.

Costs of blasting are estimated to range from 22 cents to 30 cents per cubic yard of rock loosened (19 cents to 26 cents per ton).

After blasting, the loosened blocks of limestone are extracted from the quarry by dragline. Those presently in use have a bucket capacity ranging from about 6 cubic yards to 11 cubic yards. (one company has recently placed an order for a 25-cubic yard dragline at a cost of \$2.2 million). The wet limestone is lifted from the quarry and placed on a surge pile, where partial

drying occurs. Handling the water, or excavating the wet limestone, adds an estimated 26 percent<sup>1</sup> to the power requirements for excavating. The limestone is then transported by truck or conveying system from the surge pile to primary and secondary crushers for reduction and final sizing to end-use specification.

The total cost of producing specification crushed stone varies with hardness of the rock, quarrying depth, specifications of the final products, and to some extent, with the size of the operation. Detailed costs studies are not the object of this report. It is estimated, however, that the average total cost in southeastern Florida for blasting, extracting, conveying, and sizing to specification ranges from about \$1.25 to \$1.65 per ton. In 1971, the average price for crushed limestone in southeastern Florida was \$1.42 per ton, f.o.b. plant.

An estimated 95 percent of crushed stone is moved to points of consumption by contract truckers; the remainder is transported in company-owned trucks or loaded at the quarry on trucks owned by building contractors, home owners, and miscellaneous small lot users. Current haulage rates charged by contract truckers range from about 15 cents to 25 cents per ton for the first mile, and from 5 cents to 10 cents per ton for each mile thereafter.

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<sup>1</sup>Calculated on the following basis:

1 cu ft water	= 62.5 pounds
1 cu ft Miami Oölite	= 85 pounds
Effective porosity of Miami Oölite	= 15 percent

$85 \text{ lb/ft}^3 + 15 \text{ percent} \times 62.5 \text{ lb} = \underline{94.4 \text{ lb/ft}^3}$   
(total weight of limestone + water in pores)

ADD: 20 percent water not in pore space but lifted  
in dragline bucket. 20 percent  $\times 62.5 \text{ lb/ft}^3$   
= 12.5 lb/ft<sup>3</sup>

Thus, the total weight of 1 cubic foot of saturated limestone, plus the additional weight of extraneous water in the dragline bucket, equals 106.9 pounds, or 26 percent more than in dry quarrying.

## APPENDIX B.--ENVIRONMENTAL EFFECTS OF QUARRYING

Quarries generally have three factors in their operation that are considered detrimental to the environment. These are (1) dust, (2) noise, and (3) traffic. The high water table found in southeastern Florida quarries, while detrimental to the economics of quarry operations, is a definite benefit in suppressing dust and noise associated with these operations. During extraction by dragline, the limestone is saturated, and dust is entirely eliminated. Water sprays are employed during crushing to suppress dust. In addition, most quarry operators use water trucks to dampen plant roads. Thus, the problem of dust is virtually eliminated, as is evident in the photographs of operating quarries (figs. B-1 and B-2).

The noise of blasting is effectively muffled by the high water table. Noise of machinery is controlled as far as possible by mufflers and other dampening devices.

The problem of traffic in the vicinity of quarries is one for which there appears to be no satisfactory solution.

Water pollution is not a major problem in southeastern Florida quarries. Temporary turbidity is created by blasting and excavating. However, quarry operations are generally self-contained, and the suspended particulate material that causes this turbidity soon settles when quarry operations cease.



FIGURE B-1. - Active quarry in Dade County.

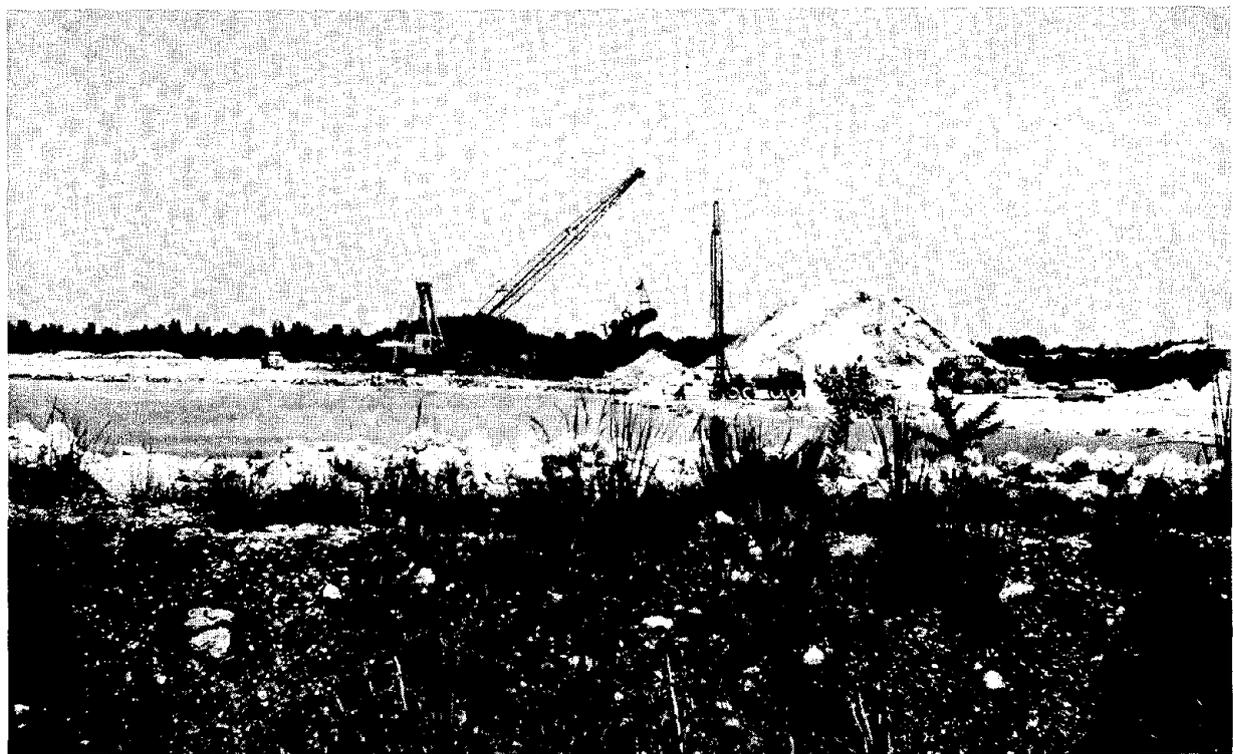


FIGURE B-2. - Active quarry in Broward County.