C. 2

State of Florida
Department of Natural Resources
Tom Gardner, Executive Director

Division of Resource Management
Jeremy Craft, Director

Florida Geological Survey
Walter Schmidt, State Geologist and Chief

Open File Report 42

A Gamma-Ray Profile Investigation of the Upper Pleistocene Miami Limestone of South Florida

by

Richard A. Johnson

Florida Geological Survey
Tallahassee, Florida
1991

A GAMMA-RAY PROFILE INVESTIGATION OF THE UPPER PLEISTOCENE MIAMI LIMESTONE OF SOUTH FLORIDA

by
Richard A. Johnson*, P.G. No. 60

ABSTRACT

The Miami Limestone of southeastern peninsular Florida consists of white to yellow to brown-yellow, oolitic or pelletal limestone. Nineteen hand-held scintillometer gamma-ray profiles of the Miami are obtained from outcrops in Dade, Broward, Palm Beach, and Monroe Counties, and a continuous core from Dade County. Four well-defined, alternating higher and lower intensity gamma-ray zones are detected, with a higher intensity zone at the base of the Miami directly overlying the low intensity of the Fort Thompson Formation (limestone). The uppermost Miami consists of a low intensity zone at or near land surface.

NOTE

This Open File Report is adapted from a paper presented at the Florida Academy of Sciences 55th Annual Meeting, May 10, 1991, at Saint Leo College, Saint Leo, Florida.

*Independent professional geologist (State of Florida License No. 60), P.O. Box 3560, Tallahassee 32315-3560.

The upper Pleistocene Miami Limestone consists of white to yellow to brown-yellow, very slightly to abundantly sandy (quartz), oolitic or pelletal limestone and minor oolitic or pelletal sandstone which occurs at or near land surface in southeastern and south-central peninsular Florida, and in the Lower Keys. The Miami is a relatively thin stratigraphic unit, attaining a maximum thickness of only 35 feet (Hoffmeister et al., 1967). Over most of its extent, it averages less than 15 feet thick.

Because the Miami Limestone occurs at or near land surface and is very thin, much of the formation is both above water level and masked behind casing in most water wells of the area. As a result, very little information currently exists with regard to the Miami's borehole geophysical signature, that is, gamma-ray, neutron, or electric-resistivity patterns characteristic of the formation.

In order to study the geophysical signature of the Miami Limestone, a technique was applied which utilizes surface exposures: outcrop gamma-ray profiling (Johnson, 1989). Since the Miami occurs at or very near land surface, and since a relatively large number of exposures are known to exist, the technique appeared ideal for this purpose.

Outcrop gamma-ray profiling utilizes a very sensitive, hand-held scintillometer to determine gamma photon intensity vertically across a clean surface exposure (or continuous core). The individual measurements, in standardized counts-per-second (cps), are then plotted against vertical distance along the exposure. The result is a profile which shows the gamma-ray intensity patterns characteristic of the formation in the same manner that a borehole gamma-ray log would.

For this study, gamma-ray profiles were run on a total of 18 surface exposures of the Miami Limestone in Dade, Monroe, Palm Beach, and Broward Counties. Of these 18 outcrop profiles, 6 profiles recorded a significant fraction of the total thickness of the Miami at each location (Figure 1). In addition, a gamma-ray profile was constructed using the same instrumentation on a Florida Geological Survey continuous core (W-16395, Everglades #1) obtained from southwestern Dade County (profile 2 on Figure 1). The core penetrated the underlying Fort Thompson Formation, and thus, the gamma-ray signatures of the basal contact and lower portion of the Miami could be conveniently studied.

Four gamma-ray zones were consistently detected in these profiles of the Miami Limestone (Figure 2). In this paper, these are termed gamma-ray zones 1, 2, 3 and 4, in ascending stratigraphic order. Gamma-ray zone 1 represents the basal portion of the Miami and is characterized by higher intensity. Gamma-ray zone 2, the lower-middle-Miami zone, is recorded as very low intensity. Gamma-ray zone 3, the upper-middle-Miami zone, repeats the basal zones's higher intensity. Gamma-ray zone 4, representing uppermost-Miami, is again characterized by lower intensity.

Figure 3 gives an index of lithologic patterns used in the

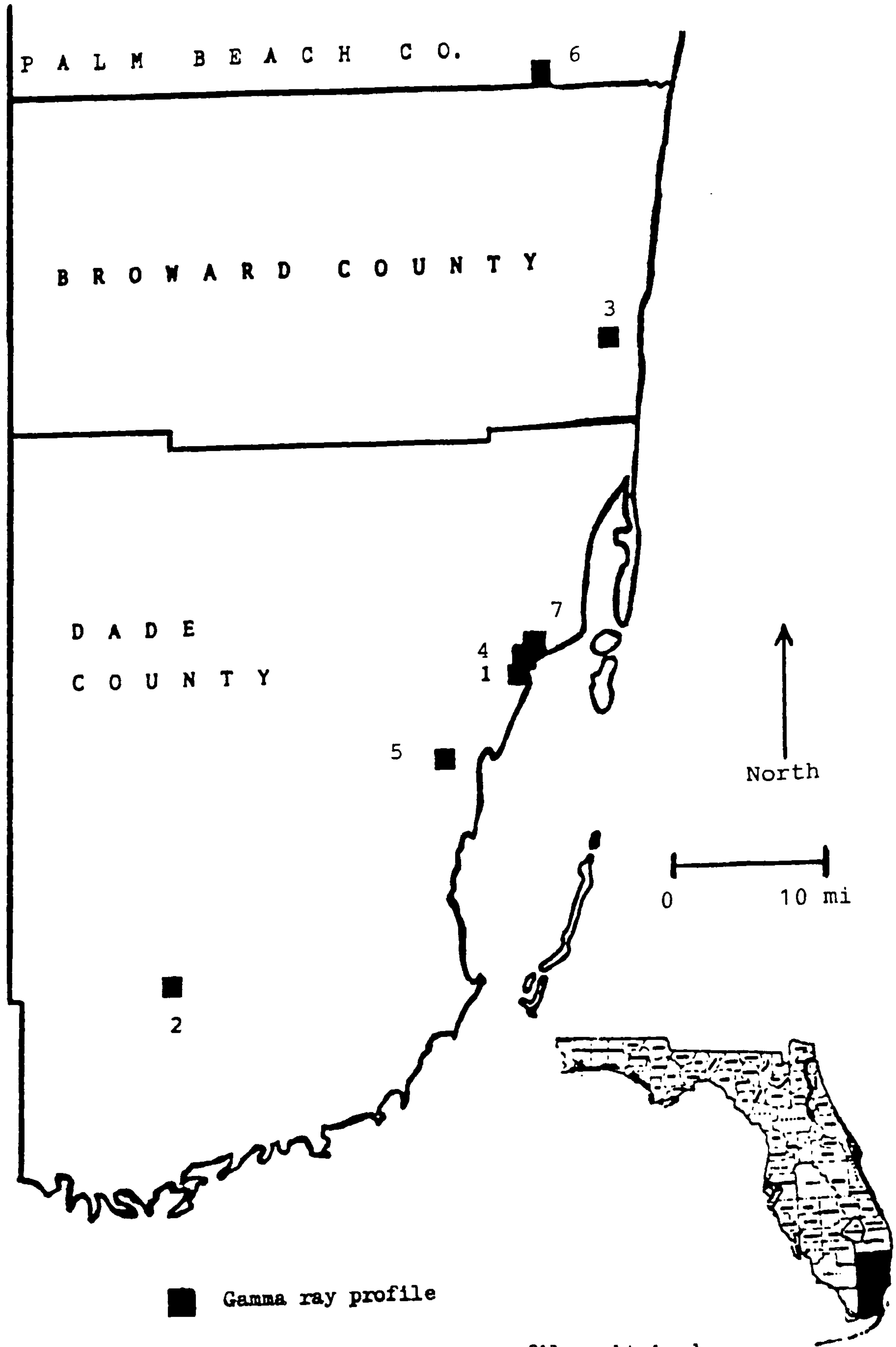


Figure 1. Locations of relatively thick gamma ray profiles obtained from the Miami Limestone.

COMPOSITE GAMMA RAY PROFILE OF THE MIAMI LIMESTONE

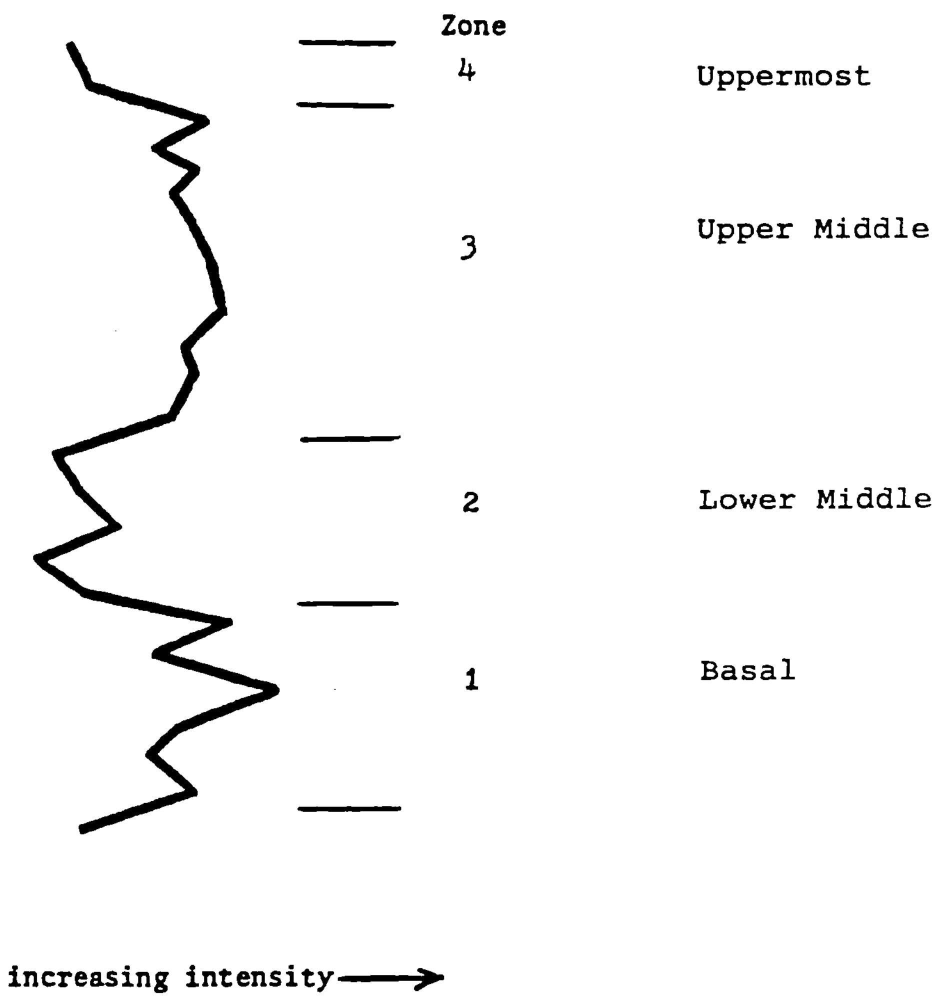
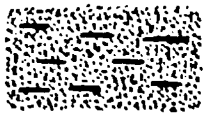
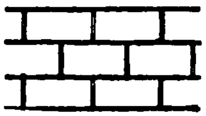


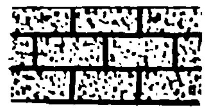
Figure 2. Composite gamma ray profile of the Miami Limestone.



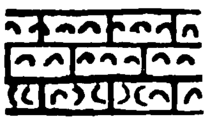
argillaceous, slightly organic quartz sand (nonoolitic)



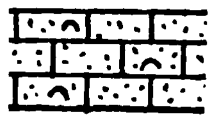
ooid calcarenite



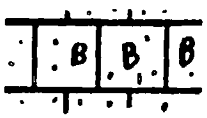
massive quartz sandstone (oolitic)



molluskan calcirudite (oolitic, *Donax* sp. or *Chione cancellata*)

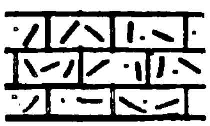


oomoldic recrystallized

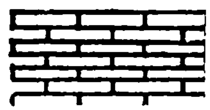


Cheilostome bryozoan calcirudite (oolitic)

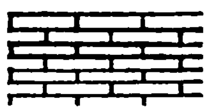
burrowed quartz sandstone (oolitic)



foraminiferal (*Archaias* sp.) calcirudite (oolitic)



massive ooid calcarenite

FT 

massive unfossiliferous, very finely recrystallized limestone (nonoolitic)

Figure 3. Index of lithologic patterns used in the figures of this paper.

figures of this report. See also Johnson (1991) for a complete list and general areas of occurence of the 5 lithofacies found to be characteristic of the Miami Limestone.

The thickest exposure of the Miami Limestone (Figure 4) is located just north of the traffic circle at the intersection of LeJeune Road and Sunset Drive in the city of Coral Gables, Dade County (Puri and Vernon, 1964), where the Coral Gables Waterway transects the Atlantic Coastal Ridge (Township 54 south, Range 41 east, Section 29, southeast quarter of southwest quarter). The 19 feet of limestone exposed here consist predominantly of cross-bedded ooid calcarenite facies (Johnson, 1991), with three very thin beds of Donax sp. molluskan calcirudite subfacies (Johnson, 1991). This exposure represents slightly more than one-half of the total thickness of the Miami Limestone at this location.

The gamma-ray profile of this exposure (Figure 4) shows: a very small portion of the basal-Miami, higher intensity, zone 1; a very well-defined, lower-middle-Miami, low intensity, zone 2; a relatively thick and well-defined, upper-middle-Miami, higher intensity, zone 3; and a very thin, uppermost-Miami, lower intensity, zone 4. This profile contains portions of all four gamma-ray zones characteristic of the Miami.

The gamma-ray profile obtained from the Florida Geological Survey core (W-16395) in southwestern Dade County (Township 58 south, Range 37½ east, Section 1, northwest quarter) is shown in Figure 5. Approximately 15.5 feet of slightly to highly

GAMMA RAY PROFILE 1

Coral Gables Canal

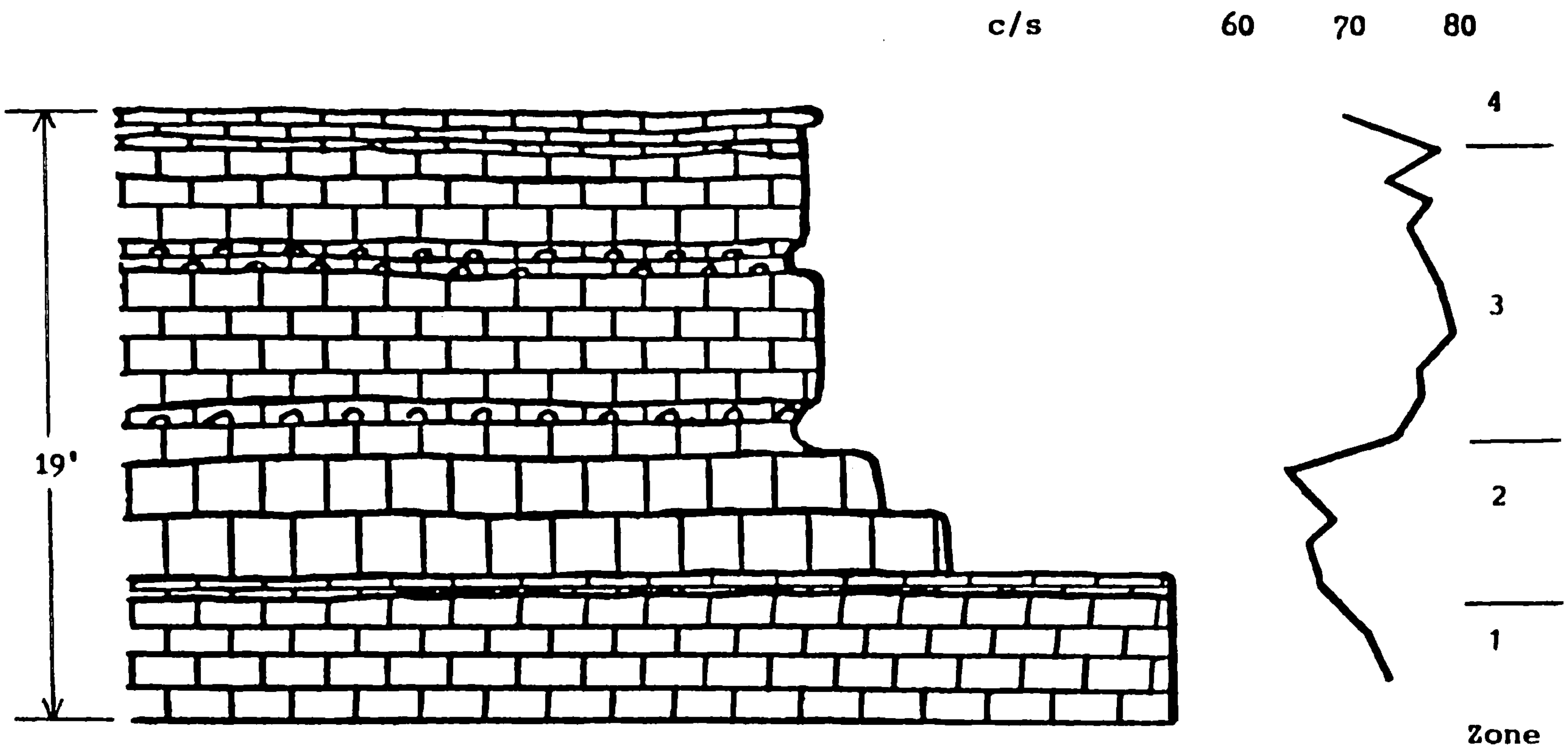
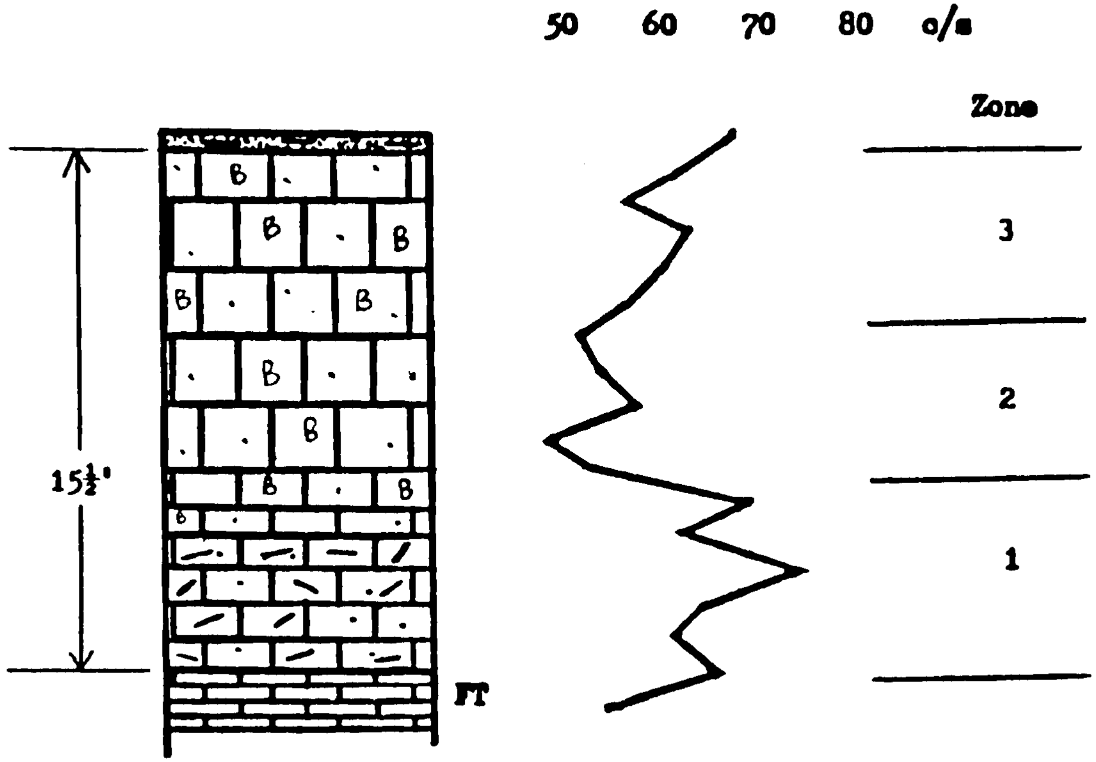


Figure 4. Section diagram and gamma-ray profile obtained from the thickest exposure of Miami Limestone, Dade County. See Figure 3 for index of lithologic patterns.

GAMMA RAY PROFILE 2

Florida Geological Survey Core W-16 395



FT= Fort Thompson Formation

Figure 5. Section diagram and gamma-ray profile obtained from the Florida Geological Survey core in southwestern Dade County. See Figure 3 for index of lithologic patterns.

burrowed, bryozoan and foraminiferal calcirudite subfacies (Johnson, 1991) of the Miami overlie the nonoolitic, very finely recrystallized, very hard and massive limestone of the Fort Thompson Formation. On this profile, the basal-Miami gamma-ray zone 1 is clearly shown as a very well-defined higher intensity interval above the low intensity of Fort Thompson limestone. A very thin, slightly argillaceous, undifferentiated quartz sand bed overlies the Miami Limestone at land surface, and is recorded on the profile as slightly higher intensity. The low intensity of gamma-ray zone 2 occurs immediately above the basal-Miami, higher intensity, zone 1. Again, the low intensity of zone 2 is very well-defined on this profile. Generally, zone 2 represents the best-defined and most-correlatable gamma-ray zone in the Miami, and can be easily identified on all seven of the relatively complete profiles.

In the thickest exposure of Miami Limestone in Broward County (Figure 6), approximately 12 feet of Miami are exhibited in the walls of the Dania Cutoff Canal at the Atlantic Coastal Ridge in the city of Dania (Township 50 south, Range 42 east, Section 34, northeast quarter of northwest quarter), representing approximately one-third of the formation at this location. The Miami consists predominantly of hard, microsparry to coarsely sparry, Donax sp. molluskan calcirudite subfacies, with uppermost and basal beds of ooid calcarenite facies.

The gamma-ray profile obtained from this exposure (Figure 6) shows gamma-ray zones 2, 3 and 4 of the Miami Limestone.

GAMMA RAY PROFILE 3

Dania Cutoff Canal

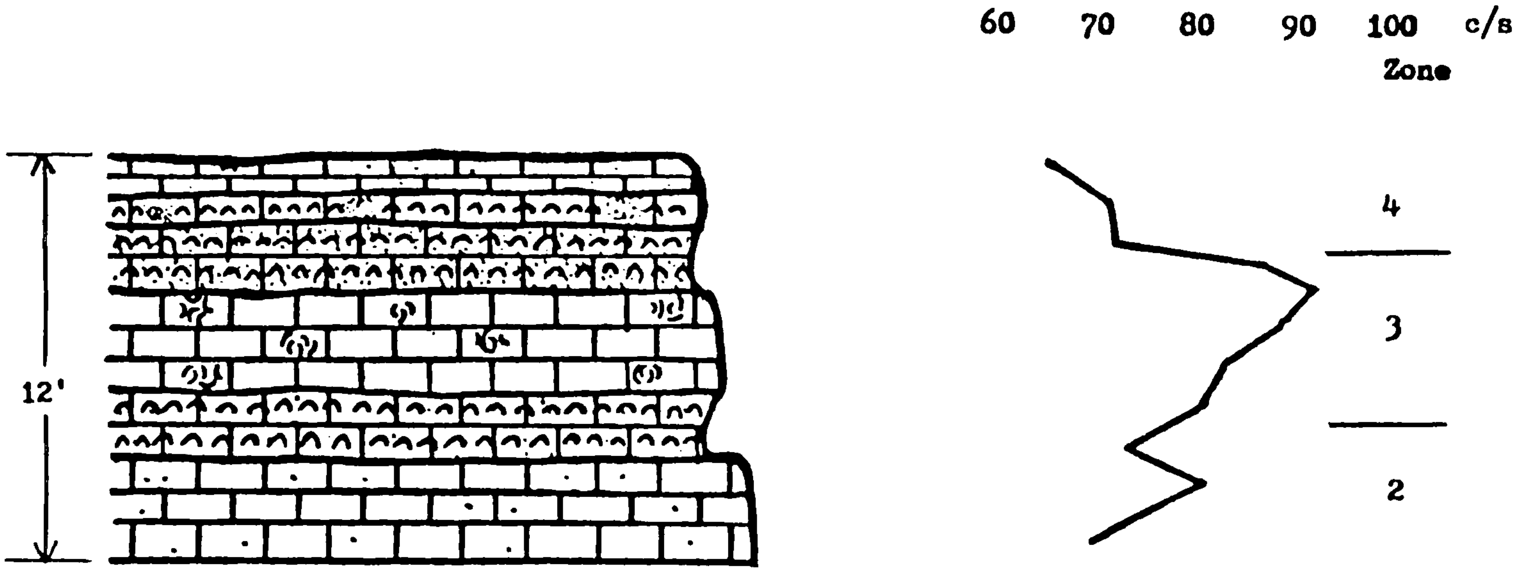


Figure 6. Section diagram and gamma-ray profile obtained from the thickest exposure of Miami Limestone in Broward County. See Figure 3 for index of lithologic patterns.

The lower intensity of the top of zone 2 at the base of the exposure generally correlates with non-shelly, very burrowed, ooid calcarenite facies. The top of the Miami (also non-shelly ooid calcarenite) is recorded on the profile as the low intensity of zone 4.

The thickest exposure of the Miami in Palm Beach County (Figure 7) occurs in the banks of the Hillsboro Canal (Township 47 south, Range 41 east, Section 26, southwest quarter) where a maximum thickness of 10 feet is exposed at extreme low water level. This thickness represents more than three-quarters of the formation at this location. The Miami consists of slightly sandy (quartz), massive, <u>Chione cancellata</u> molluskan calcirudite subfacies; abundantly sandy (quartz), massive unfossiliferous calcilutite to massive, unfossiliferous, oolitic quartz sandstone facies (Johnson, 1991); very burrowed oomoldic-recrystallized facies (Johnson, 1991) with common <u>C. cancellata</u>; and somewhat burrowed, <u>C. cancellata</u>-rich, oolitic quartz sandstone facies at the base.

The gamma-ray profile of the exposure (Figure 7) exhibits zones 2, 3 and 4 of the Miami Limestone. Zones 3 and 4, the upper two zones, are very well-defined and relatively thick, however, only the extreme uppermost portion of zone 2, the lower-middle-Miami, lower intensity zone, is recorded. This profile exhibits the same shape as the previously-considered profile from the Dania Cutoff Canal in Broward County (Figure 6), since the higher intensity of zone 3 is recorded as a rela-

GAMMA RAY PROFILE 6

Hillsboro Canal

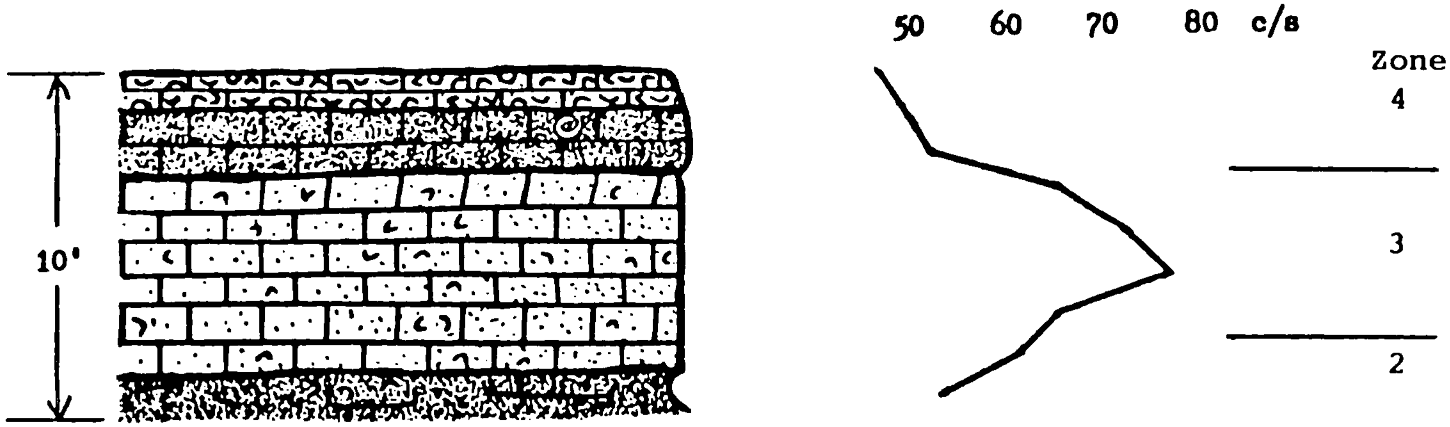


Figure 7. Section diagram and gamma-ray profile obtained from the thickest exposure of Miami Limestone in Palm Beach County. See Figure 3 for index of lithologic patterns.

tively thin peak at the top of the zone, which slowly descends into the lower intensity of zone 2 below.

Figure 8 shows a geographic correlation, from north (southeastern Palm Beach County) to south (southwestern Dade County), of the 7 most-complete gamma ray profiles obtained from the Miami Limestone. Mean sea level (MSL) is represented by the horizontal dashed line. Profile 2, most of which is below MSL, represents the Florida Geological Survey core in southwestern Dade County. Profile 6 represents the Hillsboro Canal, Palm Beach County, exposure near the northernmost extent of the Miami. Gamma-ray zones 2, 3 and 4 can be identified on all of the outcrop profiles, and the general curve shape remains consistent across the entire area (however, no correlation between lithology and gamma-ray intensity was identified in the Miami Limestone).

Because no relatively thick and complete exposures of the Miami Limestone occur in the Lower Keys of southern Monroe County, no gamma-ray profiles of the Miami obtained from that area are illustrated in this paper. However, zones 3 and 4, the upper 2 zones, are recognizable on all profiles of the Miami obtained from the Keys.

In summary, the upper Pleistocene Miami Limestone of south Florida can be geophysically divided into four well-defined gamma-ray zones of alternating higher and lower intensity. The basal Miami gamma-ray zone 1 and the upper-middle Miami gamma-ray zone 3 are consistently recorded as higher intensity, and the lower-middle Miami gamma-ray zone 2 as well as the uppermost

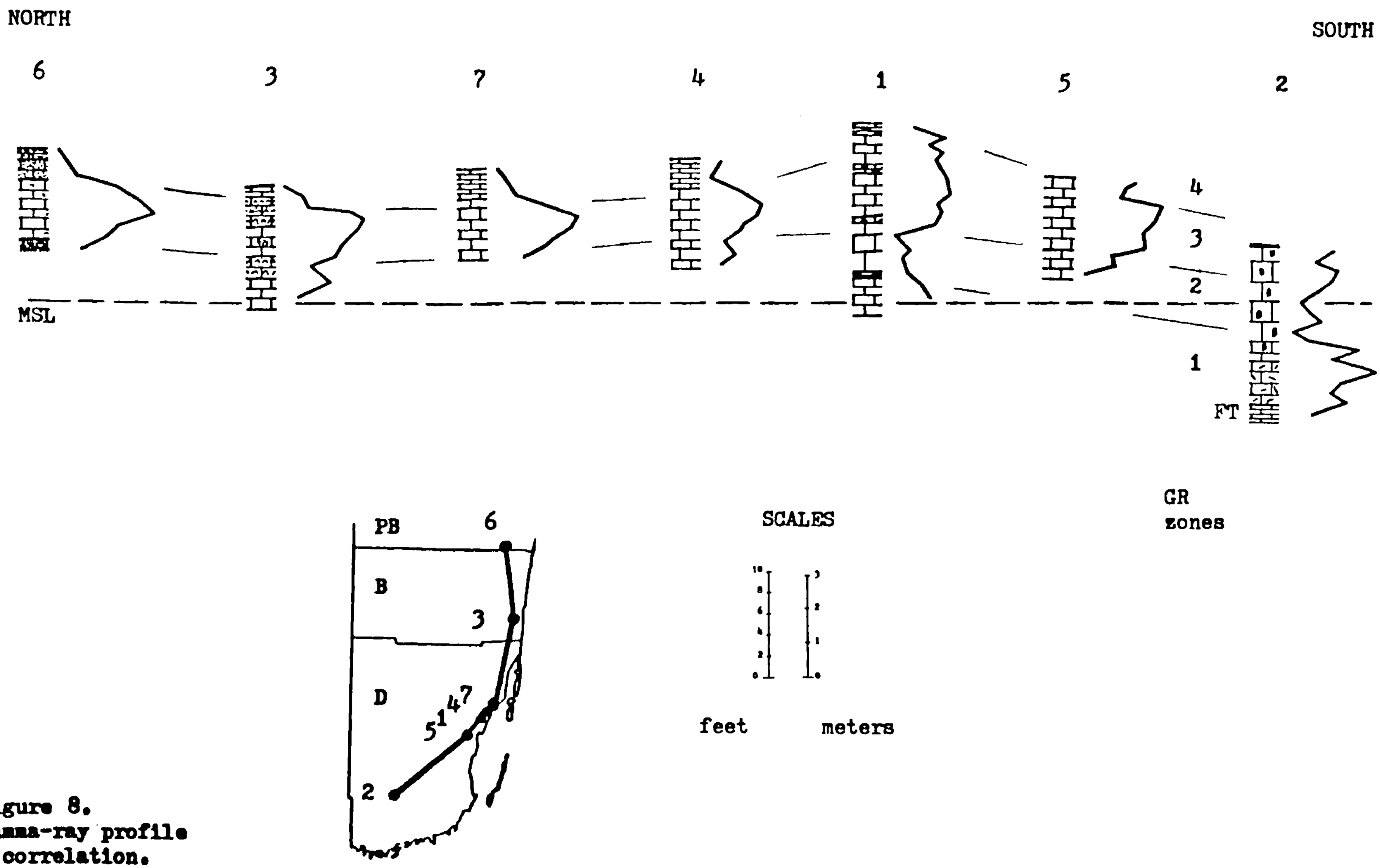


Figure 8.
Gamma-ray profile correlation.

Miami gamma-ray zone 4 are consistently recorded as lower intensity.

REFERENCES

Hoffmeister, J.E., Stockman, K.W., and Multer, H.G., 1967, Miami Limestone of Florida and its Recent Bahamian counterpart: Geological Society of America Bulletin, v. 78, pp. 175-190.

Johnson, R.A., 1989, Stratigraphic correlation of outcrop gamma ray profiles in Florida: Florida Geological Survey Open File Report 26, 27 p.

Johnson, R.A., 1991, Lithofacies of the upper Pleistocene Miami Limestone of south Florida [abstract]: Florida Scientist, v. 54, Supplement 1, p. 28.

Puri, H.S. and Vernon, R.O., 1964, Summary of the geology of Florida and a guidebook to the classic exposures (revised): Florida Geological Survey Special Publication 5 (revised), 312 p.