

# Port of Miami Tunnel

A public-private partnership project by



## Formation Stratigraphy and Interfingering at the Port of Miami

AUGUST 6, 2012

[www.portofmiamitunnel.com](http://www.portofmiamitunnel.com)



# PROJECT PARTNERS

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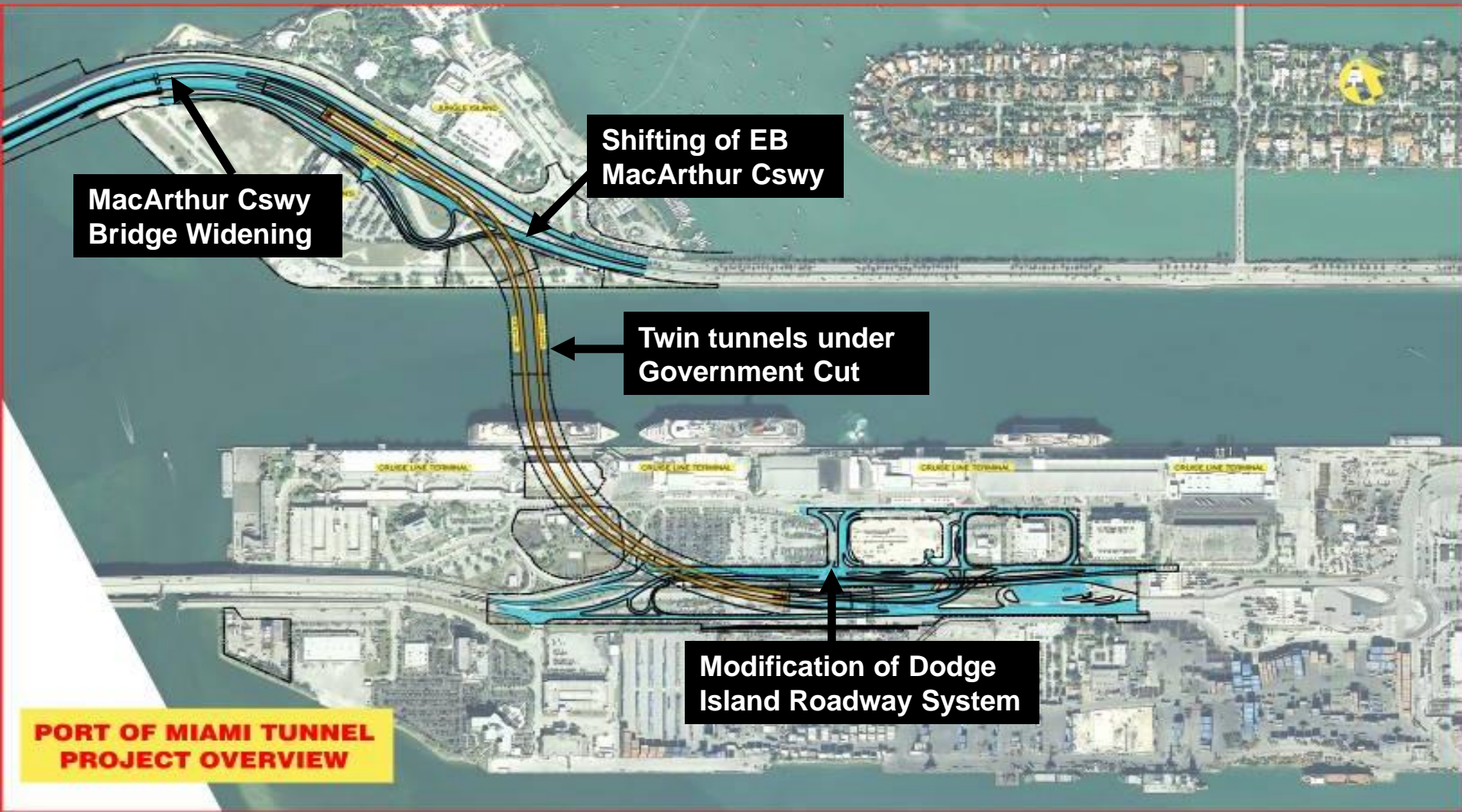


A public-private partnership created by    

# FUNDING PARTNERS

- FDOT contributing 50% of capital cost
- Miami-Dade County contribution \$402.5M
  - (includes right-of-way cost)
- City of Miami contribution \$50M
- Construction Cost \$607M + \$180M Geotechnical Contingency
- FDOT fully funding Tunnel Operations & Maintenance from statewide maintenance funds (about \$200 million over 30 years)

# SCOPE OF WORK



**PORT OF MIAMI TUNNEL PROJECT OVERVIEW**

# TUNNEL BORING MACHINE (TBM) ASSEMBLY

- Arrived June 23, 2011 and came in several pieces (75 regular cargo, 20 containers and 19 heavy haul pieces). Took 4 months for assembly including testing and commissioning
- Shield consists of 6 pieces
- Trailing gear is comprised of 6 gantries



# TUNNEL BORING MACHINE



- TBM cutter head with an outside diameter of 42.3 feet (as high as a 4 story building)
- 361 foot long trailing support gear made up of 6 gantries
- Total length of the TBM is 428.5 feet long (more than a football field).

# TUNNEL BORING MACHINE BREAK-IN



The Tunnel Boring Machine (TBM) began cutting into the ground on November 11, 2011 and the first permanent ring was installed on November 18th, 2011.



# TBM SEGMENT DELIVERY & INSTALLATION



MSV transporting segments in TBM



Segments being lifted for placement by TBM

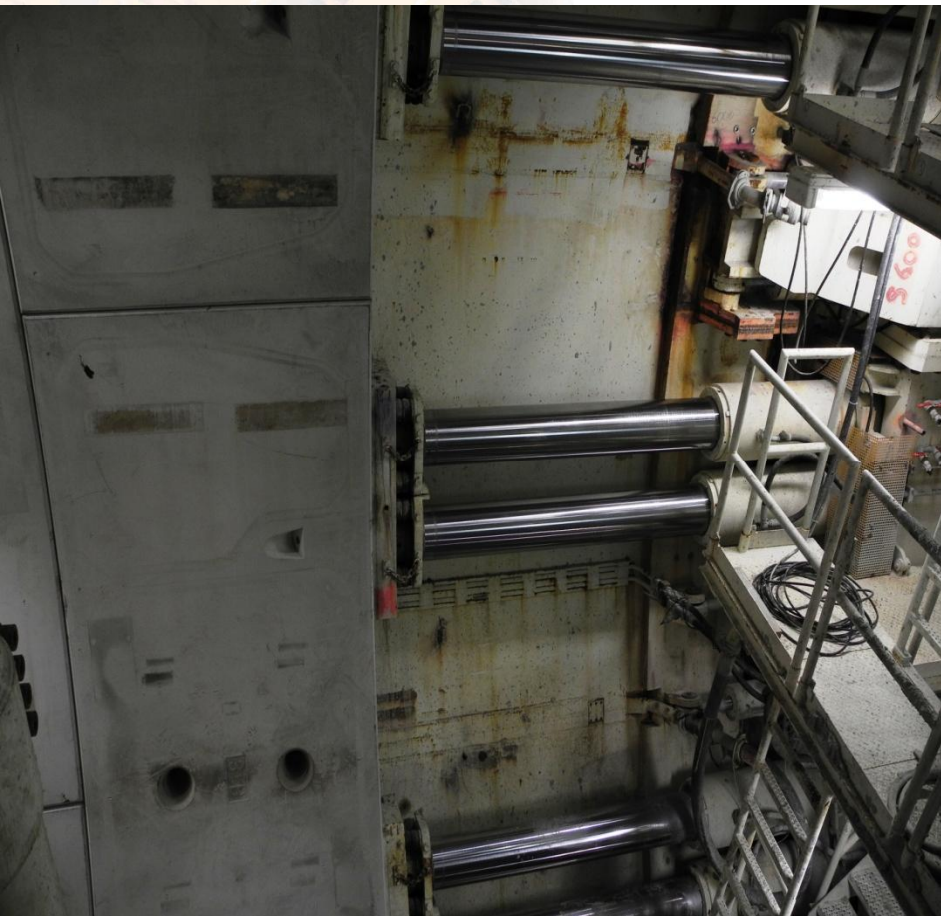
Segment Feeder on TBM

# SEGMENT PRODUCTION



- Cemex Plant in Sweetwater
- 12,000 Concrete segments will line tunnel
- Over 7,500 produced to date
- 8 Segments = 1 tunnel ring
- Segments are:
  - 2 ft thick
  - 5 ft 7 in Wide
  - 14 ft 6 in Long
  - 13 Tons

# VIEW INSIDE THE TBM



# VIEW INSIDE THE TBM



# TBM TUNNELING EASTBOUND



- Eastbound tunnel under construction.

# TBM TUNNELING EASTBOUND



- At breakout on Dodge island on July 31, 2012, the TBM had bored about 4,200 feet through the ground.
- Now, the TBM will be turned around and sent back to Watson Island.

# PRELIMINARY CONCEPTUAL INTERIOR VIEW OF TUNNEL

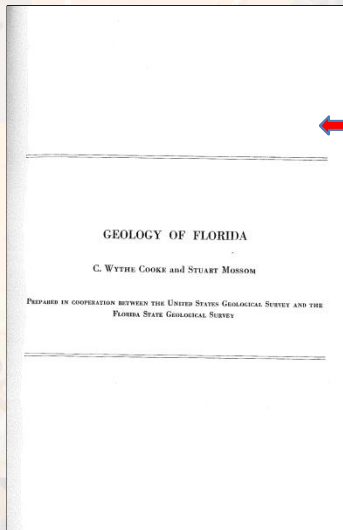




# Stratigraphy and Interfingering of the Fort Thompson Formation

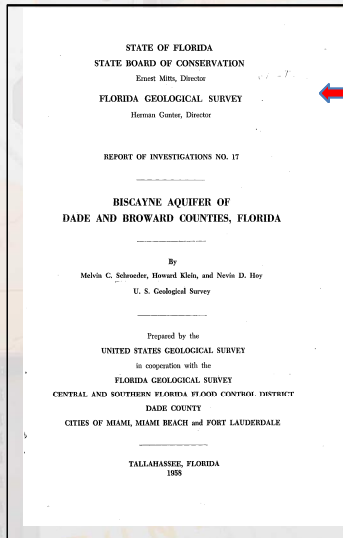
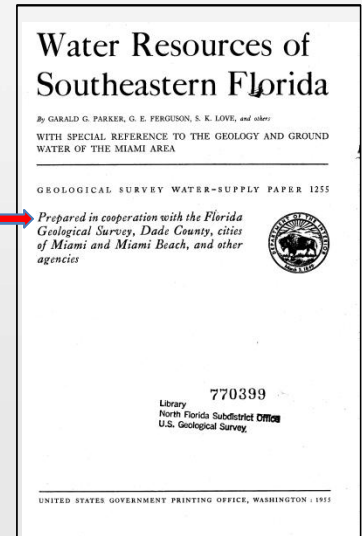


# Formation Defining Publications for Southeast Florida



Cooke, C.W., and Mossom, S., 1929, Geology of Florida: Florida Geological Survey 20<sup>th</sup> Annual Report, p. 29-227.

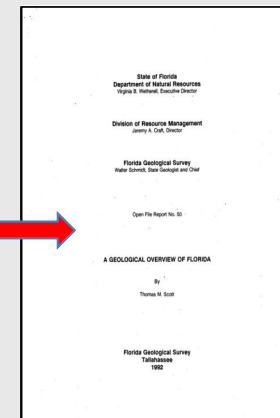
Parker, G.G., Ferguson, G.E., and Love, S.K., 1955, Water Resources of Southeastern Florida, U.S. Geological Survey Water-Supply Paper 1255, 965 p.



Schroeder, M.C., Klein, H., and Hoy, N.D., 1958, Biscayne Aquifer of Dade and Broward Counties, Florida: Florida Geological Survey, Report of Investigation No. 17, 56 p.

Tom Scott (Assistant State Geologist)

Scott, T.M., 1992, A Geological Overview of Florida, Florida Geological Survey, Open File Report No. 50, 79 p.



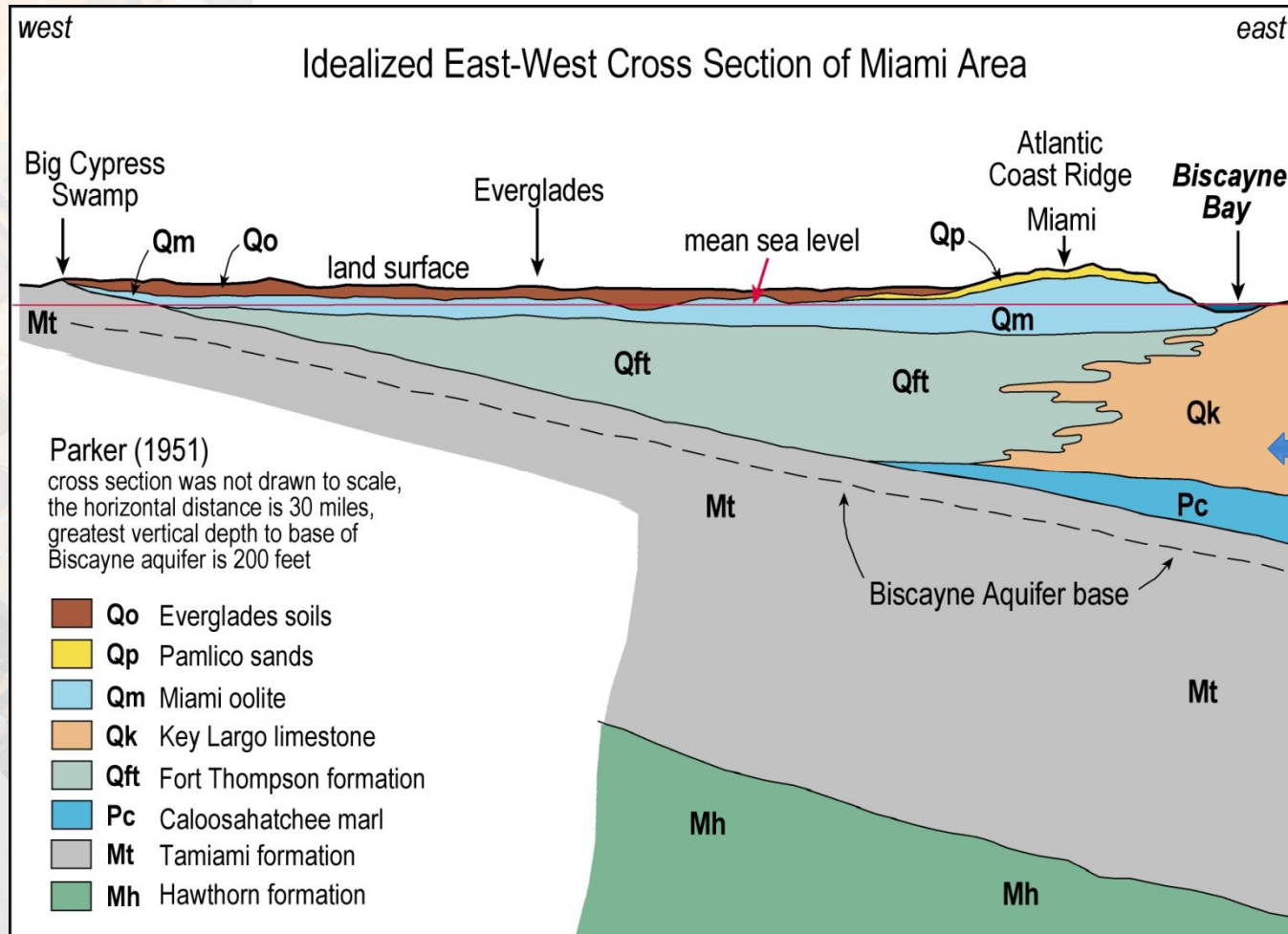
Slide credit, Dr. Donald F. McNeill, Ph.D., PG

# Stratigraphy (Geologic Layers) at the Tunnel Site

<i>Epoch/Age</i>	<i>Stratigraphic Nomenclature</i>
Holocene 11.7 Ka	unconsolidated sediment <b>Pamlico Sands</b>
Late 126 Ka	<b>Miami (Oolite) Limestone</b>
Pleistocene	<b>Anastasia Formation</b>
	<b>Fort Thompson Formation</b>
	<b>Key Largo Limestone</b>
Early 781 Ka	
2.59 Ma	
Pliocene Late	<b>Tamiami Formation</b>

Slide credit, Dr. Donald F. McNeill, Ph.D., PG

# Key Largo Limestone in the Miami – Biscayne Bay Region

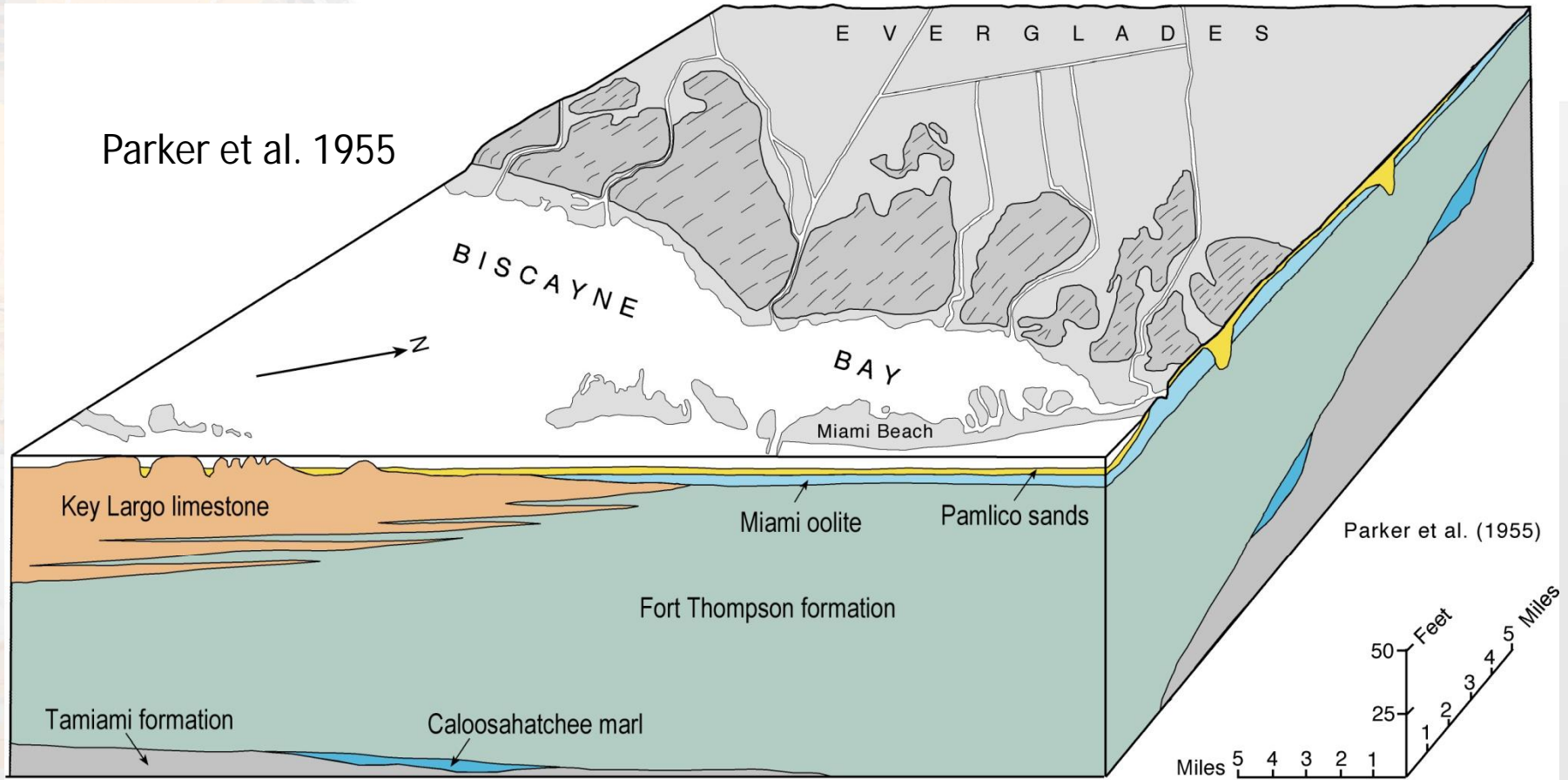


Key Largo Limestone

Interfingering beneath Biscayne Bay known since the 1950's

Slide credit, Dr. Donald F. McNeill, Ph.D., PG

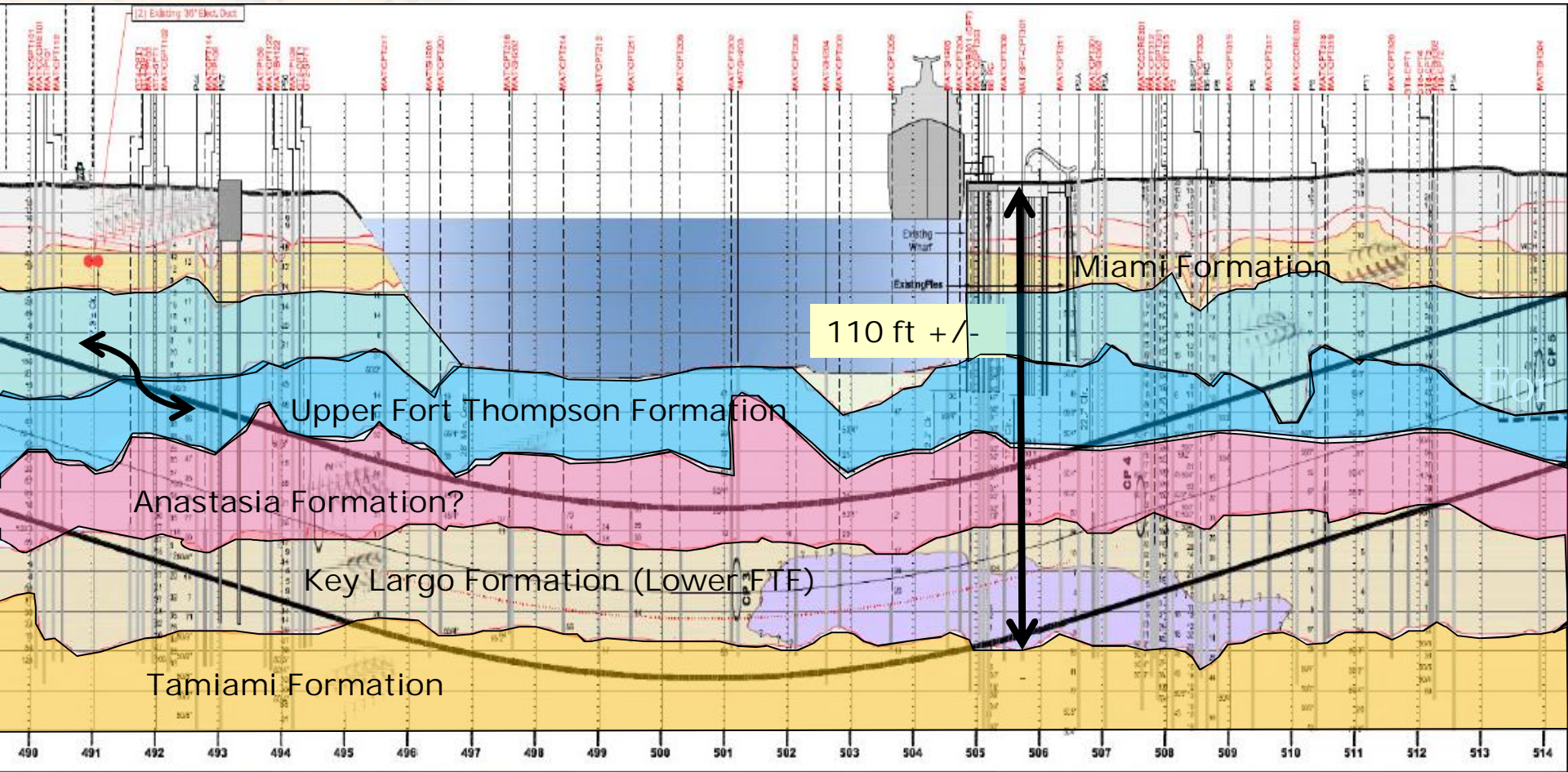
# Interfingering of Fort Thompson Formation & Key Largo Limestone



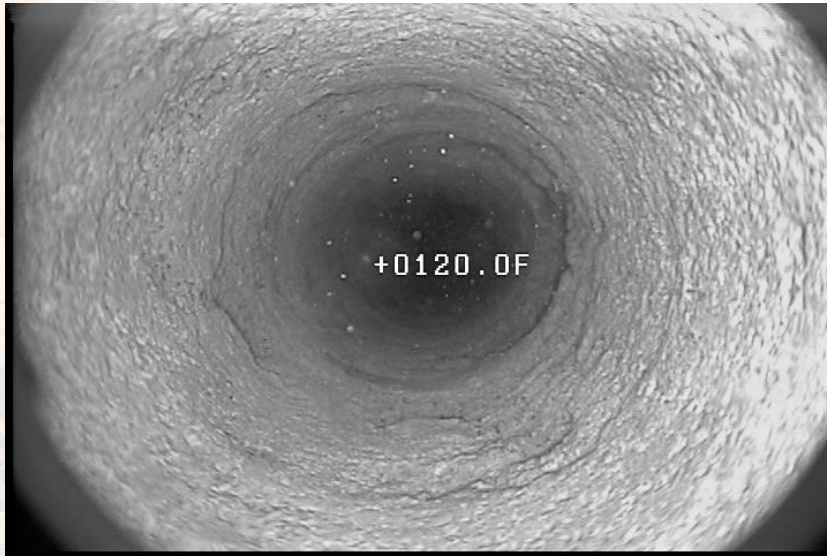
**BLOCK DIAGRAM of the MIAMI AREA GEOLOGY**

Interfingering beneath Biscayne Bay known since the 1950's

# TUNNELING PROFILE SECTION



Looking East at Government Cut



view looking down borehole

← Borehole RE-5  
near eastbound tunnel  
beneath channel

Transition base of  
Fort Thompson Fm  
(Key Largo lithology)  
to top  
Tamiami Formation

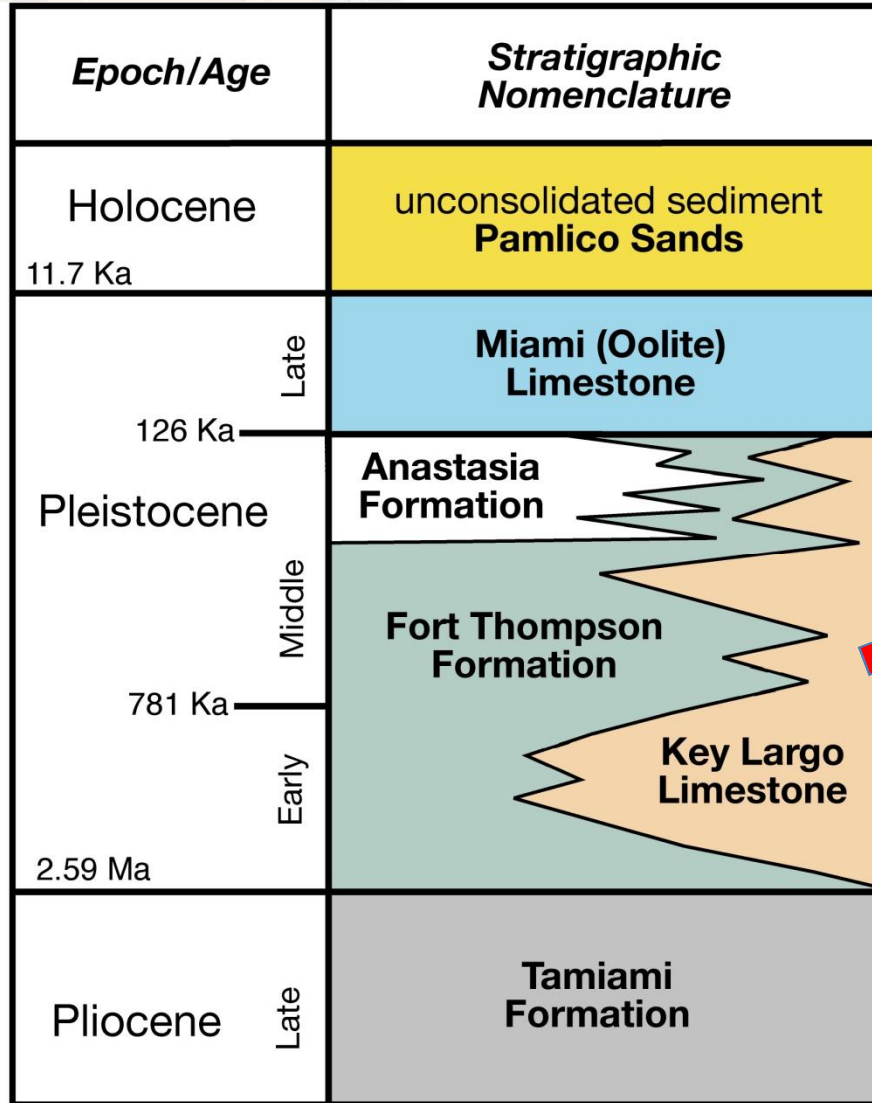


← Borehole RE-CH-1  
near eastbound tunnel  
on Watson Island

Drilled borehole diameter 6-inches

Slide credit, Dr. Donald F. McNeill, Ph.D., PG

# Key Largo Limestone Interfinger in Fort Thompson Formation



From Scott (1992):

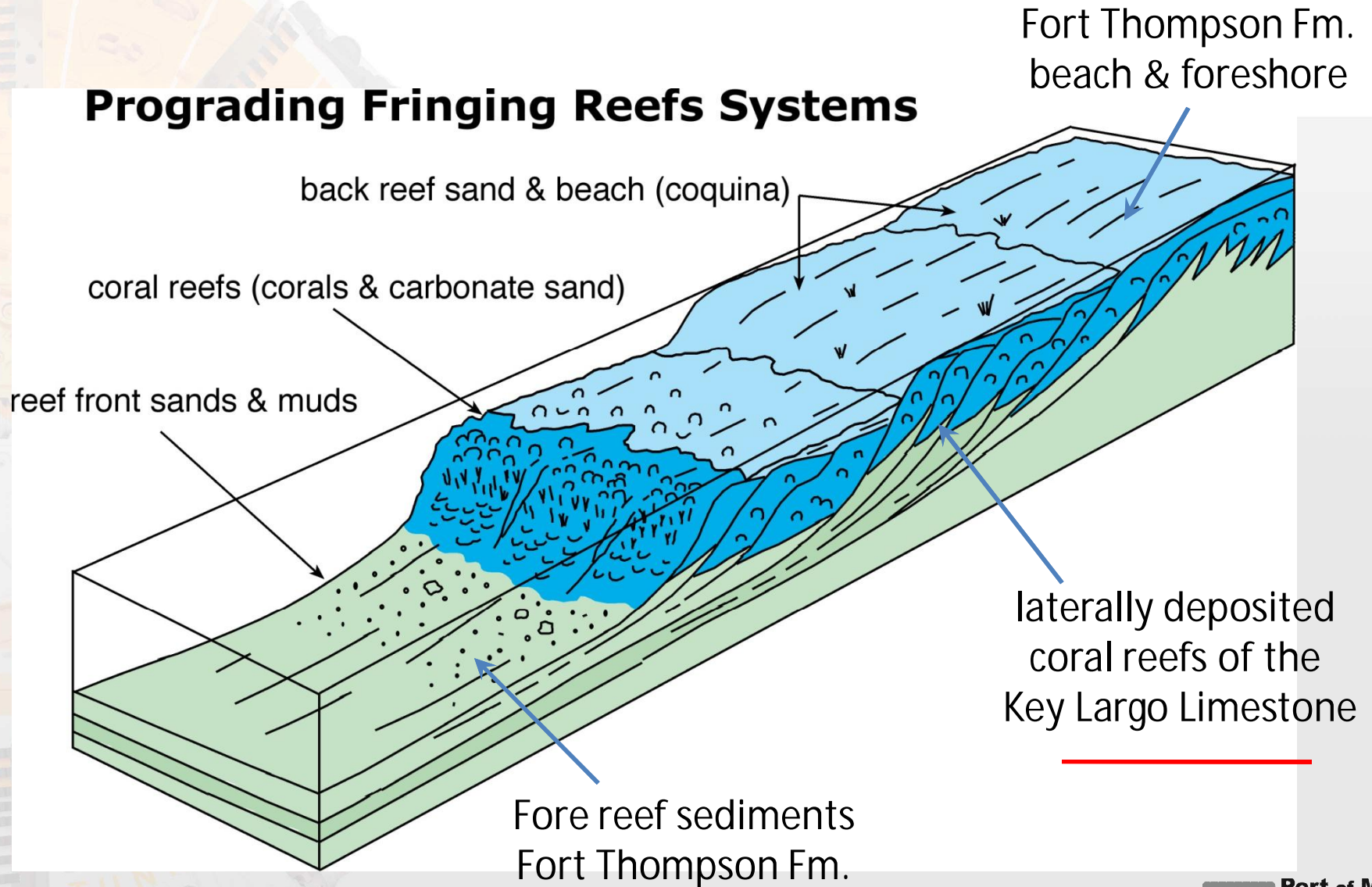
Coralline limestone composed of coral heads encased in a matrix of calcarenite (*cemented carbonate sand*)

Key Largo Limestone occurs in the subsurface from as far north as Miami Beach to as far south as the Lower Keys

The fossil reef tract represented by the Key Largo may be as much as 8 miles wide

# Geological Model of Key Largo Limestone Reefs at Port of Miami

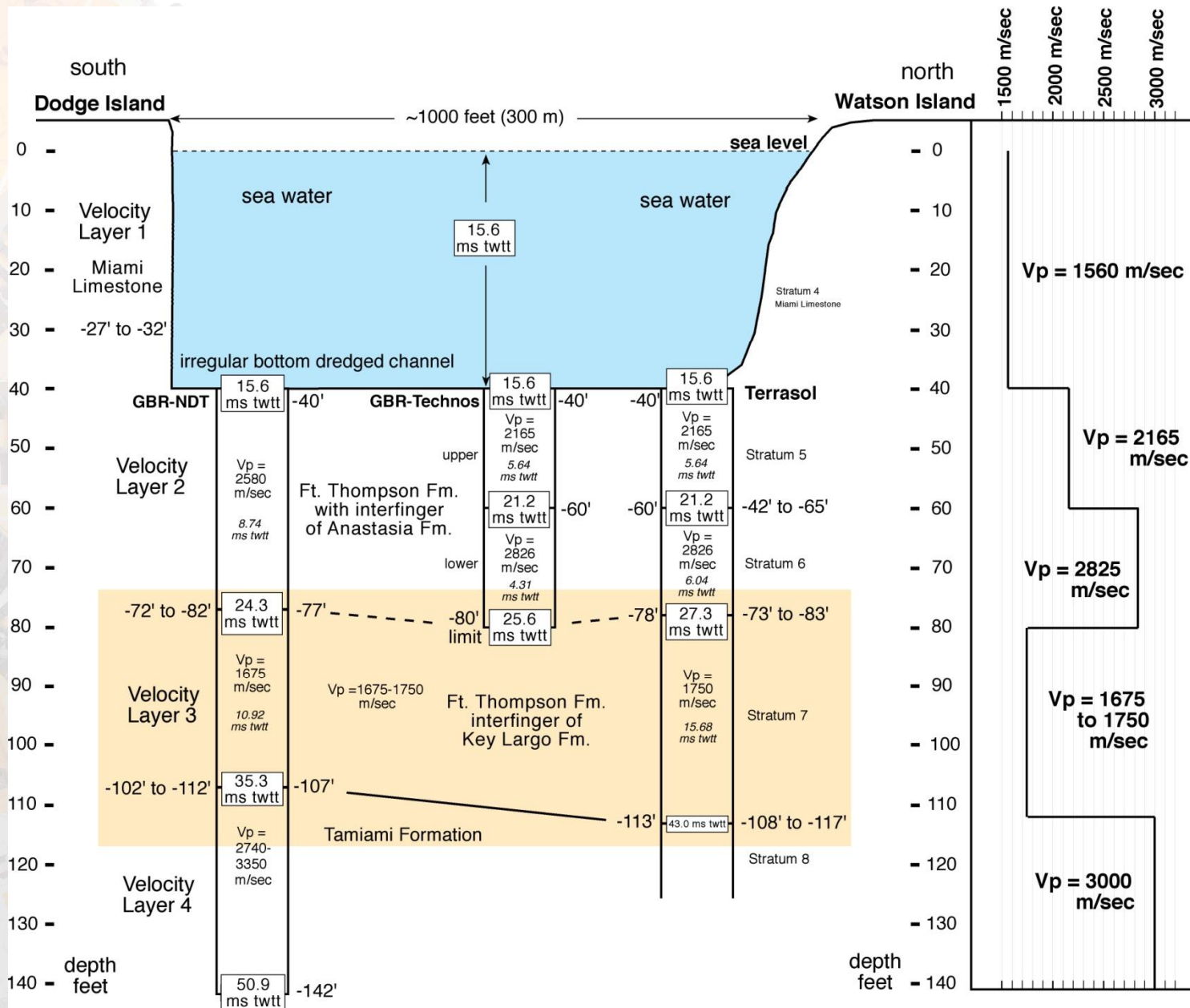
## Prograding Fringing Reefs Systems



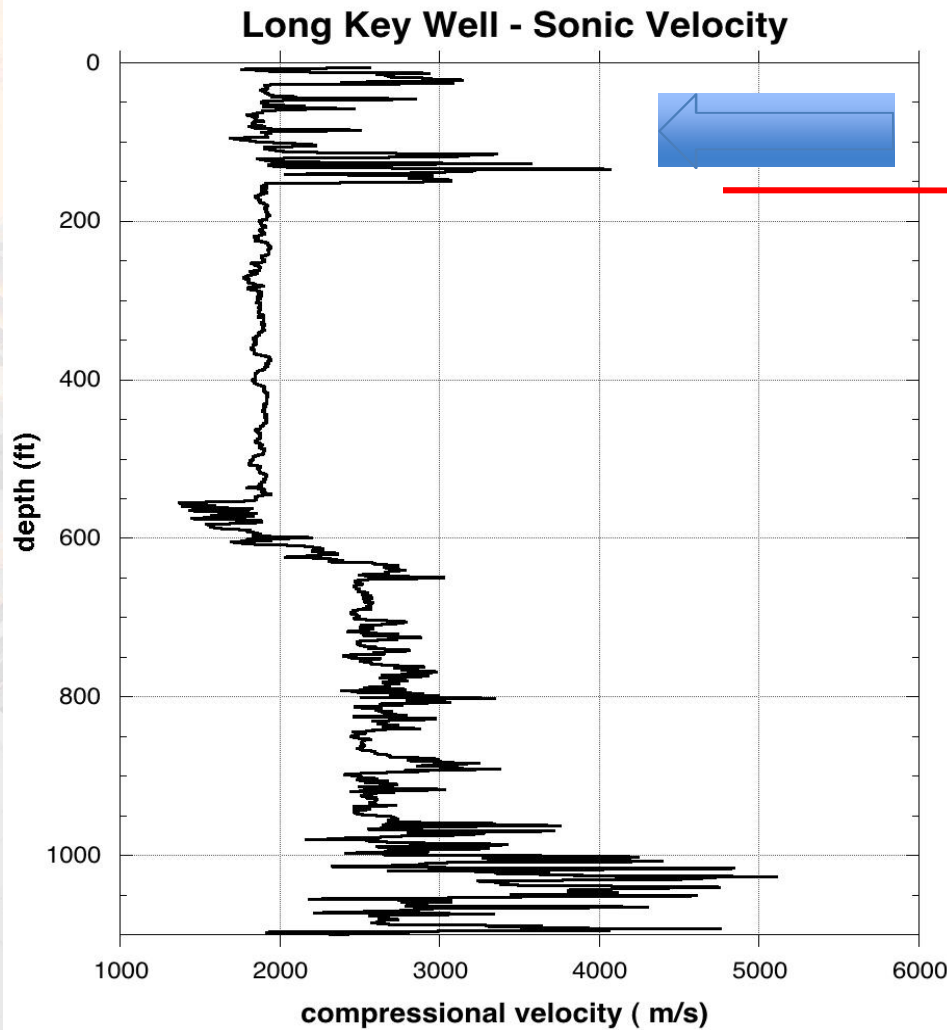
Slide credit, Dr. Donald F. McNeill, Ph.D., PG



# Velocity Model Based on Existing Site Geophysical & Geology Data



# Similar sonic velocity in cemented rock of the Key Largo Formation



Key Largo Limestone (coralline)

1-m long core photographs of Key Largo Formation lithology from Long Key core, Florida Keys (5 ft core runs)

- 1 = ~11-16 ft
- 2 = ~34-39 ft
- 3 = ~61-66 ft

Sonic log published in Anselmetti et al. 1997



1

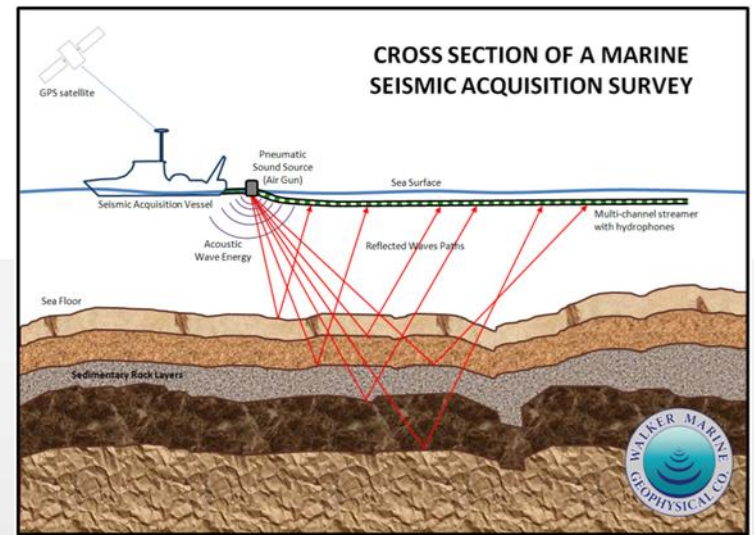
2

3

# Seismic Acquisition

## Three basic elements:

- 1) Source: sea = airgun (compressed air)
- 2) Receiver: sea = hydrophones
- 3) Geometric layout that establishes the relationship between source & receiver



24-channel hydrophone streamer

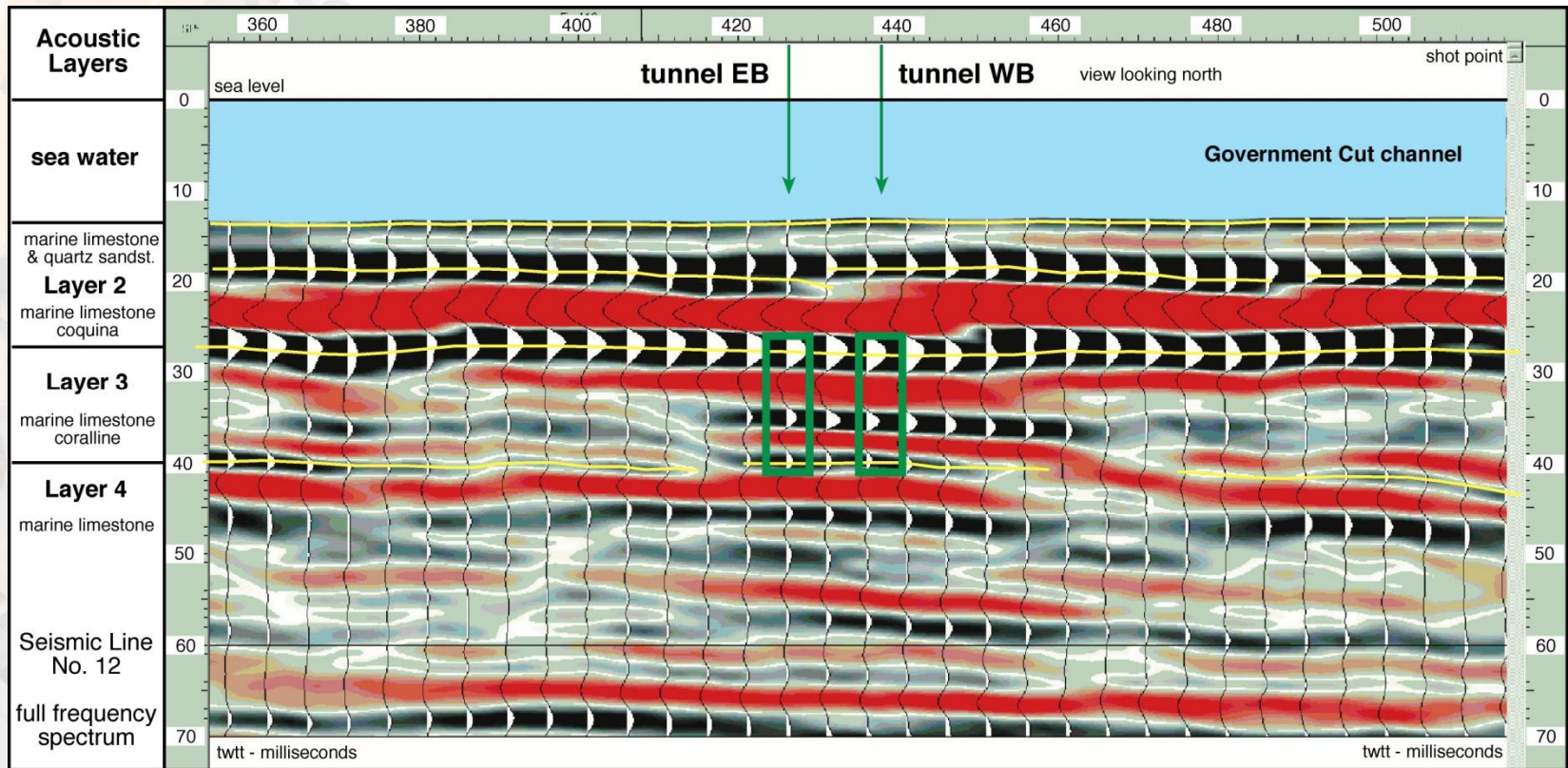


compressed air source, two 10 cu-inch Bolt airguns

Walker Marine  
Geophysical  
survey vessel



# Seismic units in the vicinity of the tunnel bores

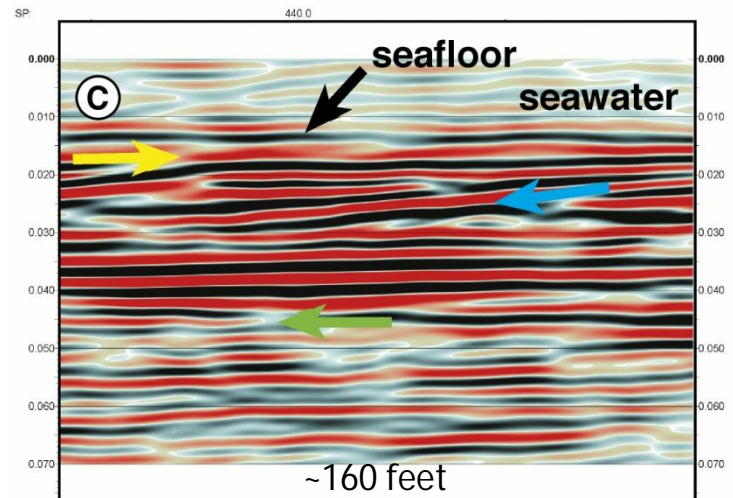
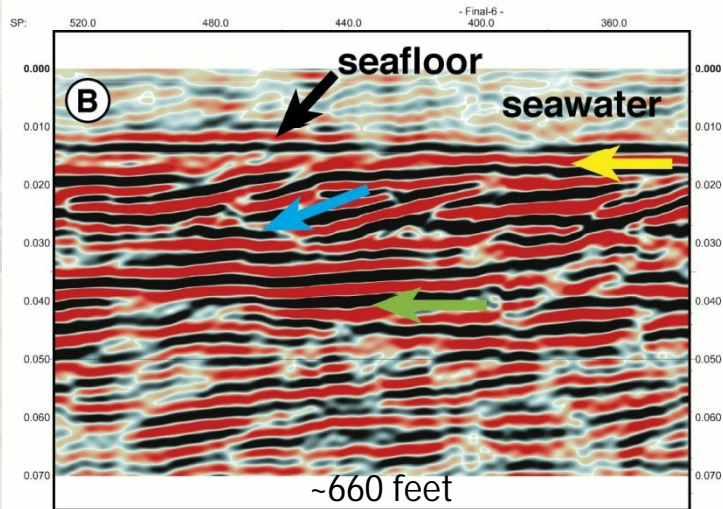
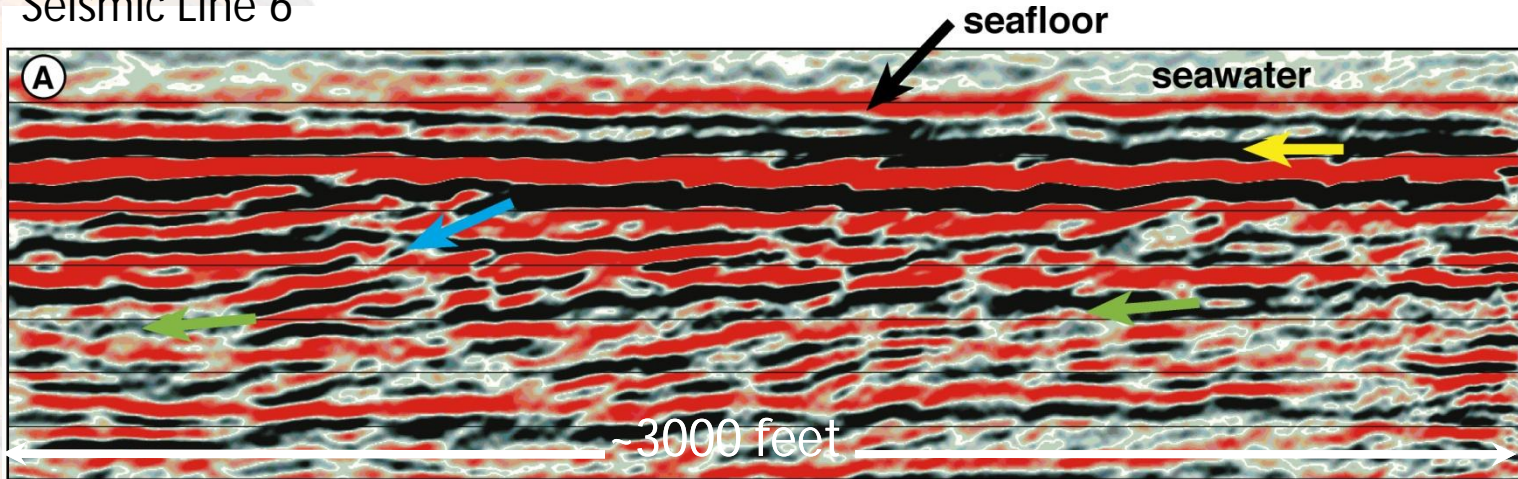


Velocity Layers, Seismic Reflection Data are Consistent with Geologic Data from Borings

Slide credit, Dr. Donald F. McNeill, Ph.D., PG

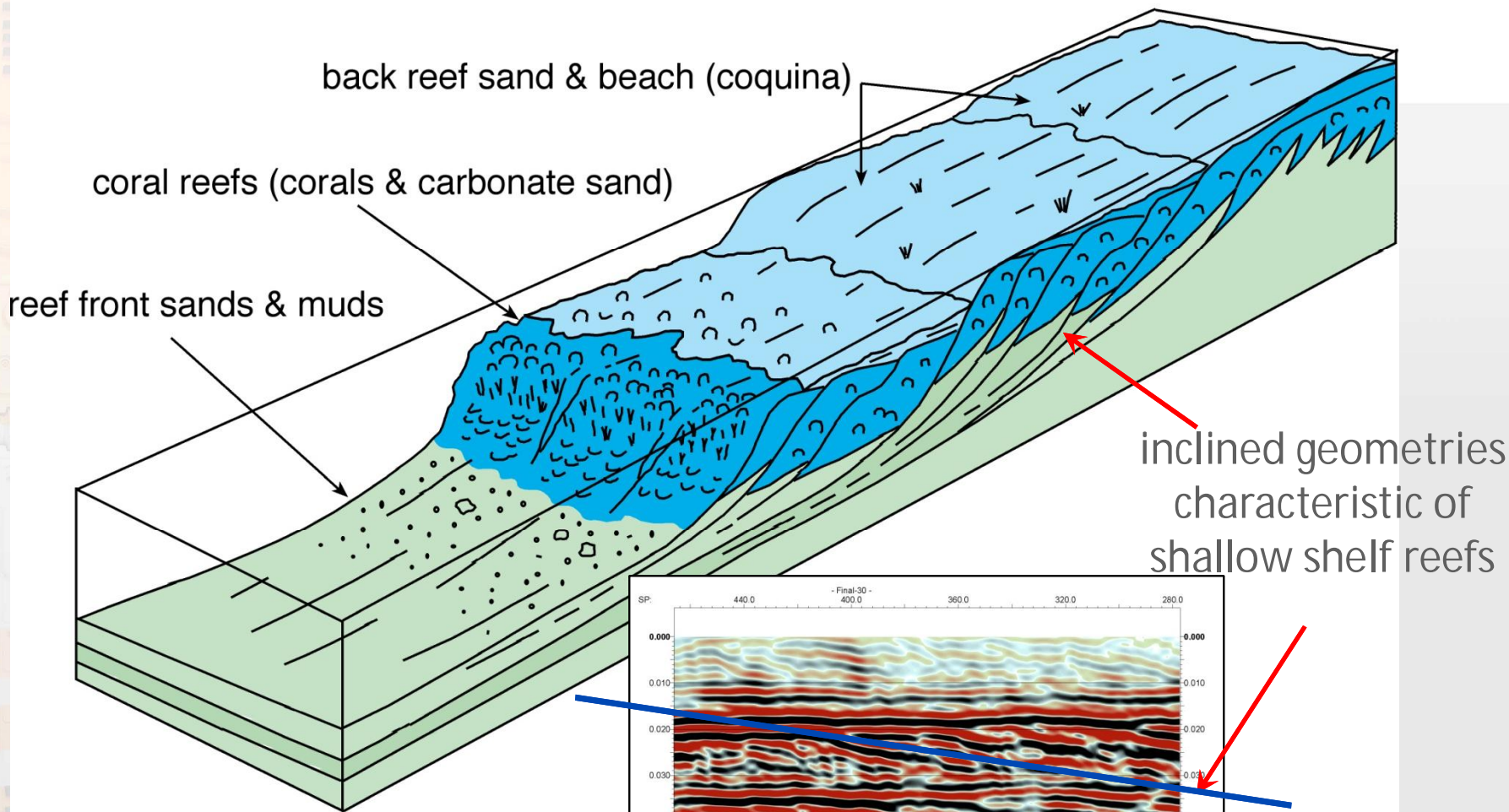
# Seismic Data Shows Preservation of Depositional Geometries

Seismic Line 6



Slide credit, Dr. Donald F. McNeill, Ph.D., PG

# Geological Model of Key Largo Limestone Reefs at Port of Miami



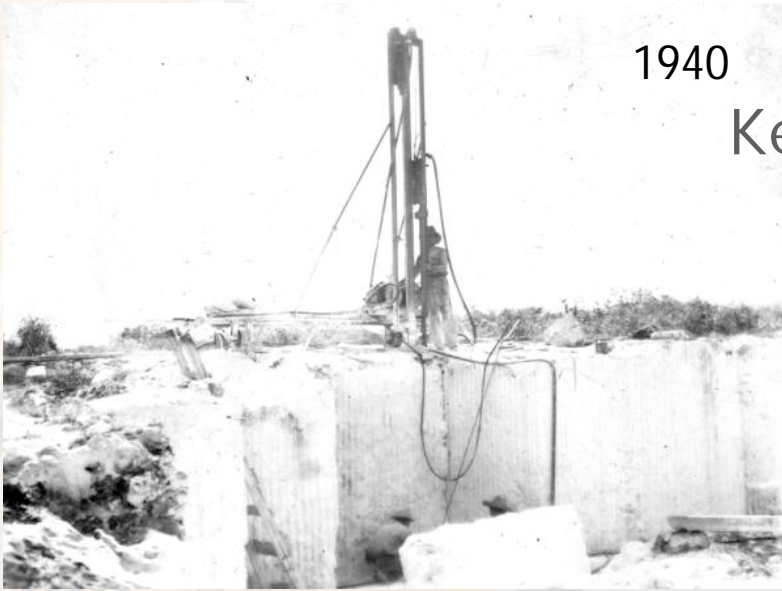
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1940

# Limestone Quarry Operations Key Largo Limestone, Florida Keys

Limestone rock used for Flagler railway  
base, then as building stone

1953

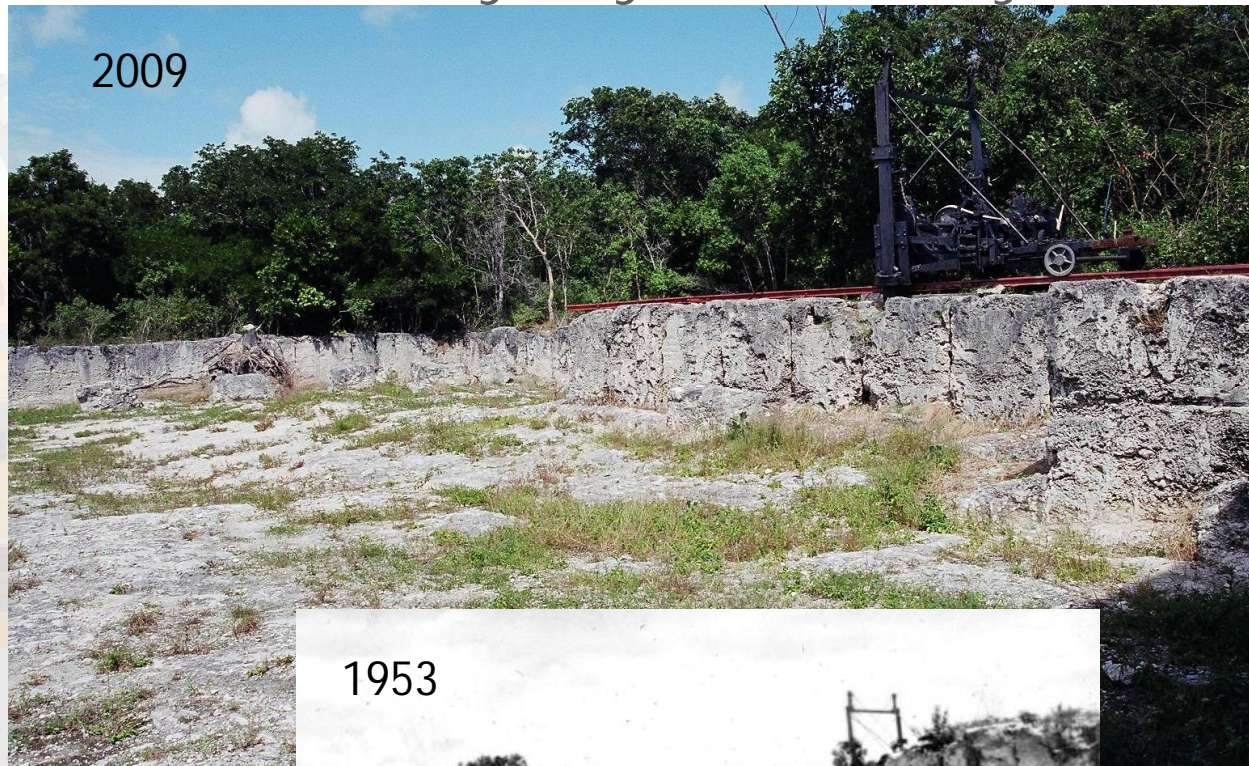


**Looking south at the Plantation Key quarry - 1935**



Slide credit, Dr. Donald F. McNeill, Ph.D., PG

# Quarry Wall of the Key Largo Limestone Windley Key, Florida Keys



2009



1953

← corals

← calcarenite (cemented carbonate sand)



# Key Largo Limestone Windley Key

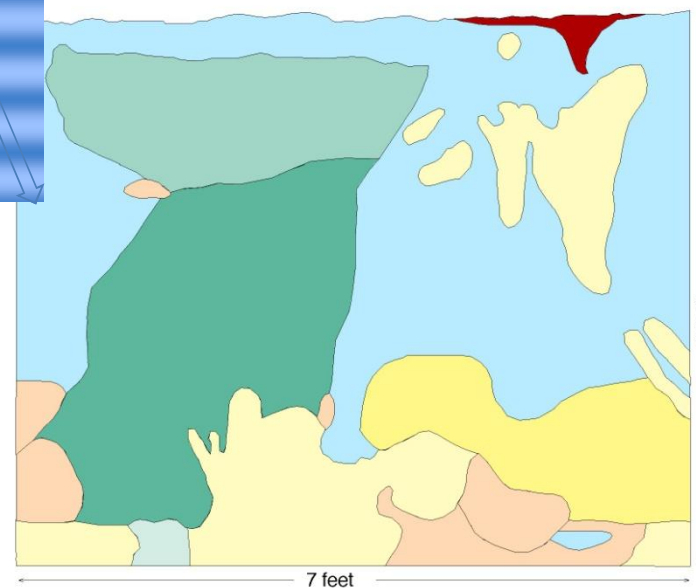
cemented  
carbonate sand  
(calcareenite) matrix



isolated coral heads in  
cemented calcarenite matrix



Windley Key Quarry



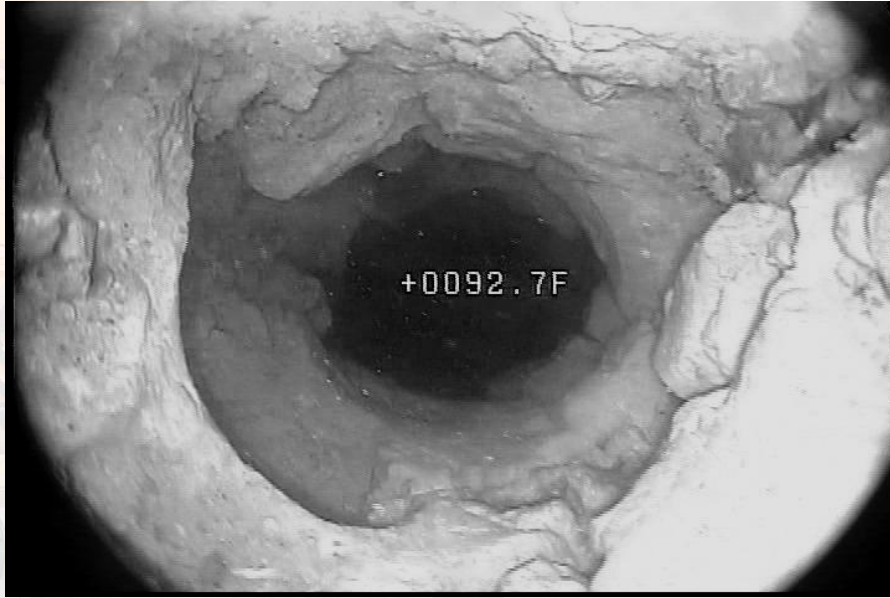
**Explanation**

- Diploria labyrinthiformis*
- Montastrea annularis*
- Porites astrooides*
- Porites porites*  
w/ coarse sediments
- Porites porites*  
w/ fine sediments
- Porites porites*

- red crust, paleosol  
(very well cemented)
- carbonate sediments  
(undifferentiated)

Diagrammatic sketch of the composition of the Pleistocene Key Largo Limestone in a wall at the Windley Key Quarry.



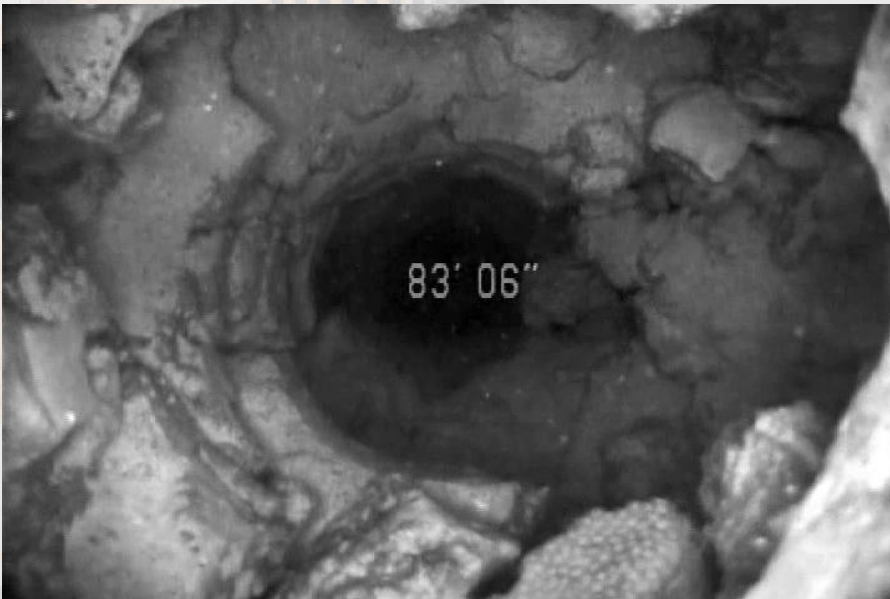


view looking down borehole

Borehole RE-5

← near eastbound tube  
beneath channel

Angular breakage  
of coral-rich unit  
(Key Largo Fm.)  
interfinger within  
Fort Thompson  
beneath channel &  
Watson Island

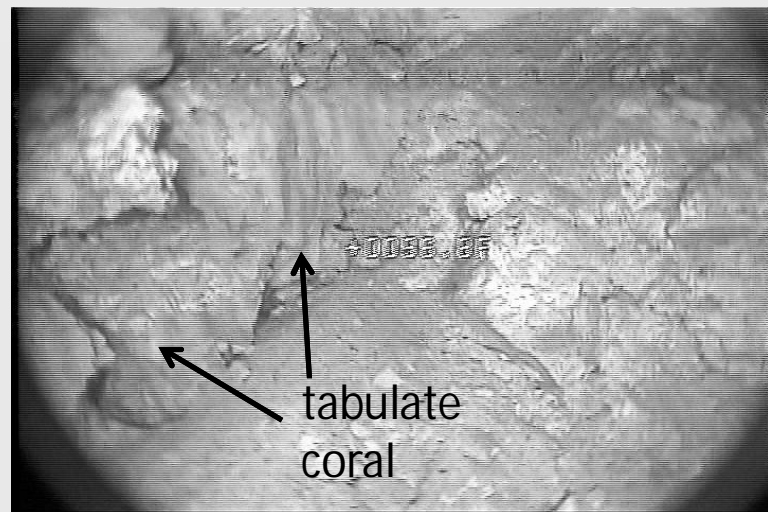
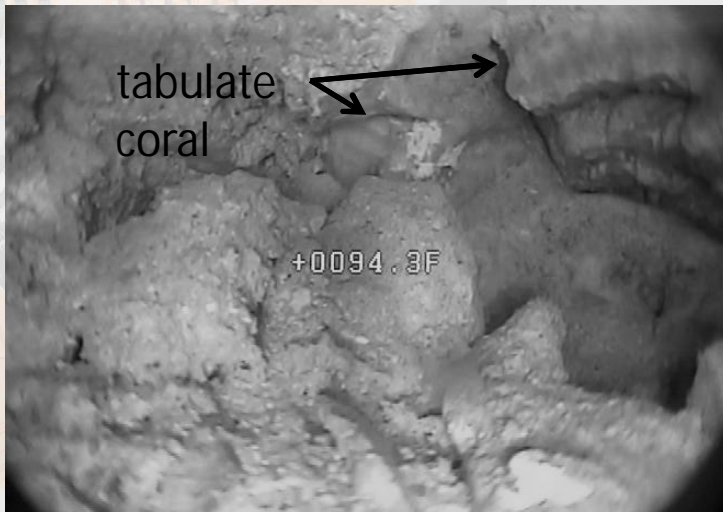
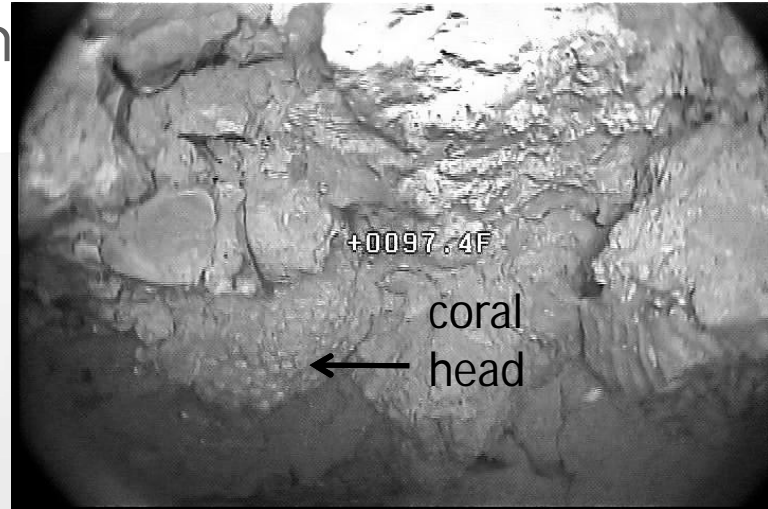
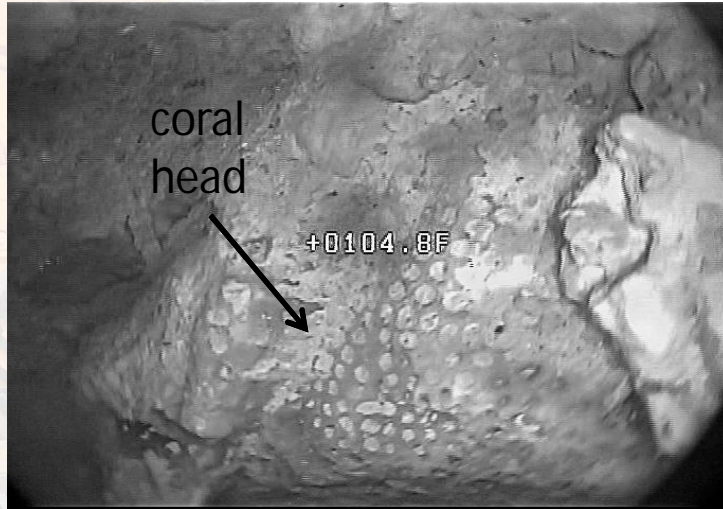


Borehole RE-CH-1

← near eastbound tube  
on Watson Island

Drilled borehole diameter 6-inches

# Well cemented coralline limestone – Key Largo



Borehole RE-5 near eastbound tunnel beneath channel

Scale is 2-4 inches  
across photo

Slide credit, Dr. Donald F. McNeill, Ph.D., PG

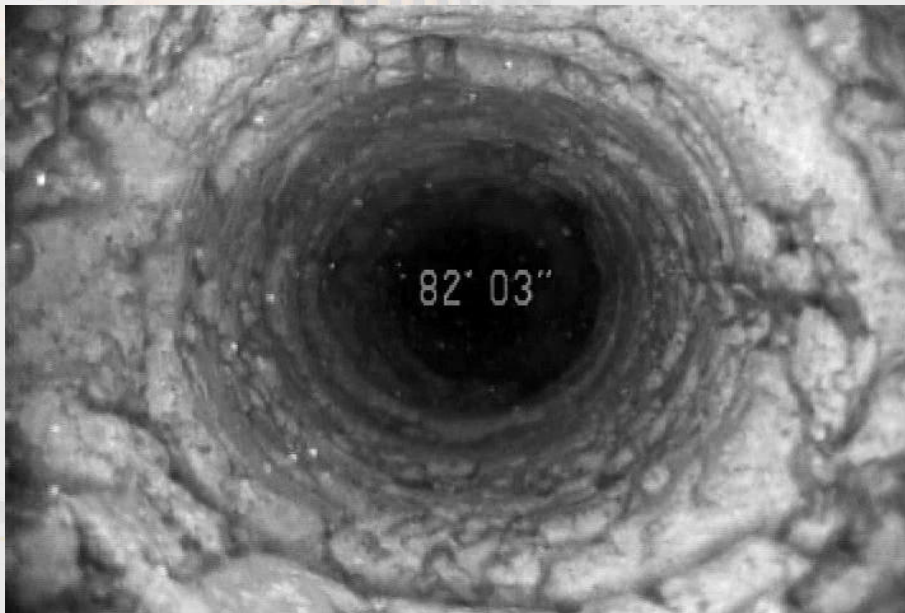


view looking down borehole

Borehole RE-5

← near eastbound tunnel  
beneath channel

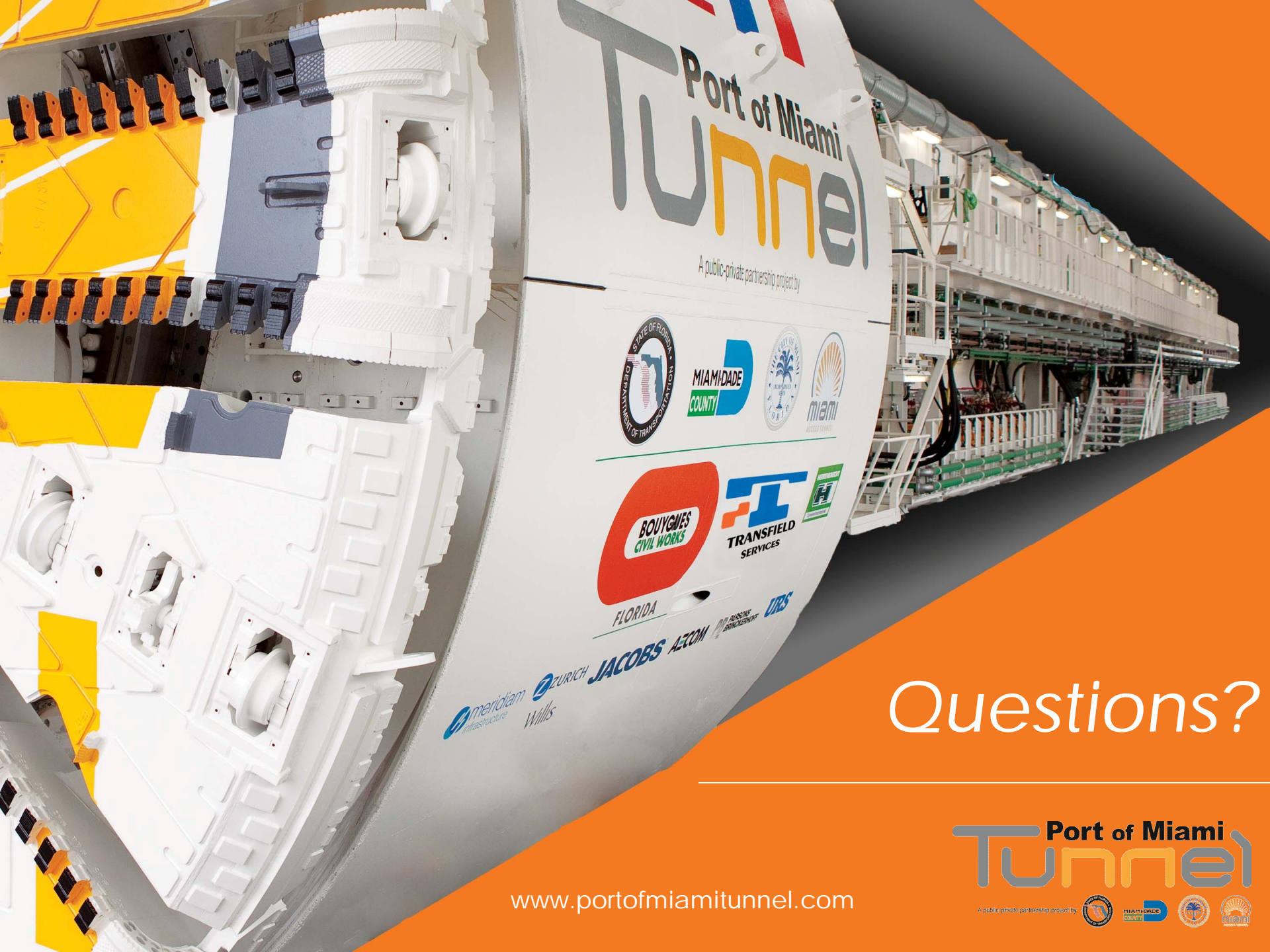
Skeletal limestone  
& coquina interfinger  
in Fort Thompson  
Formation beneath  
Ship Channel &  
Watson Island



Borehole RE-CH-1

← near eastbound tunnel  
on Watson Island

Drilled borehole diameter 6-inches



# Port of Miami Tunnel

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FLORIDA



# Questions?

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