



Turkey Point Units 6 & 7 COL Application

Status of Geotechnical and Hydrological Evaluations

Florida Power & Light Company

December 5, 2008

The information provided in the following presentation is of a preliminary nature and is considered DRAFT.

Agenda

- Introduction – Bill Maher
- Site Arrangement – Paul Jacobs
- Storm Surge and Tsunami Effects – Mustafa Samad
- General Geologic Conditions – Dave Fenster
- Subsurface Investigation Overview – John Sturman

Break

- Geotechnical Considerations – John Sturman
- Groundwater – Jerry McLane
- Construction Methods – John Sturman, Greg Davis



Site Arrangement

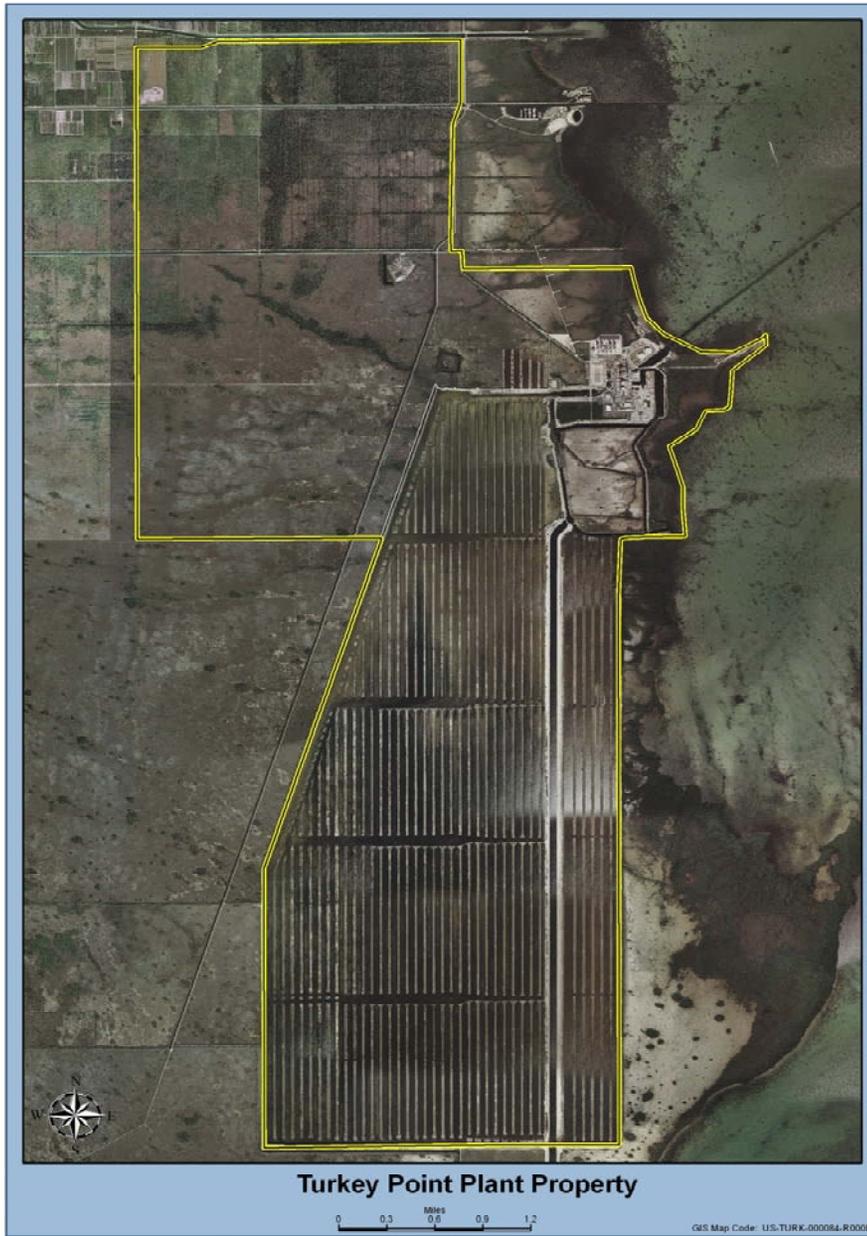
Paul Jacobs

Engineering Supervisor, FPL

December 5, 2008

General Project Information

- **Approximately 210 acre island area within the Turkey Point Plant Property**
- **Turkey Point Plant Property bordered on the east by Biscayne National Park and undeveloped wetlands on the west**
- **Located south of existing Turkey Point Units 1 thru 5 (Units 1 and 2 are Gas/Oil-Fired, Units 3 and 4 are Nuclear, Unit 5 is Gas-Fired Combined Cycle)**
- **Approximately 8 miles due east of Florida City**
- **Primarily a limestone site, with alternating layers of silty-sand and limestone**
- **AP1000 technology selected**
- **Mechanical draft cooling towers with a reservoir for storage of several days cooling water**
- **Finished grade at nuclear island will be raised approximately 26 ft due to storm surge wave run up**







Storm Surge and Tsunami Effects

Mustafa Samad

Engineering Specialist - Hydrology, Bechtel

December 5, 2008

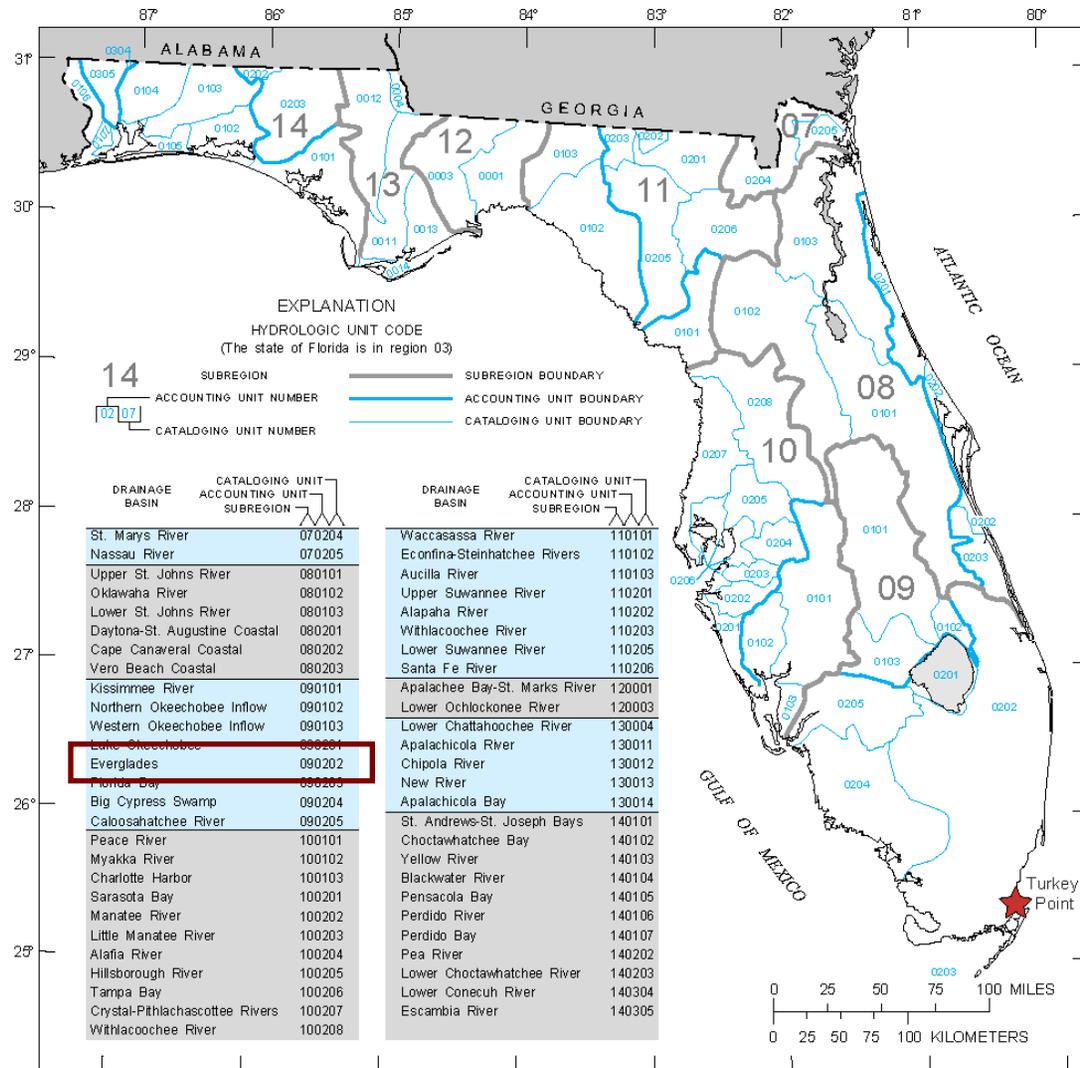
Hydrologic Description

Conceptualization of Flood Scenarios

- **Man-made canals have altered general drainage of the south Florida region**
- **No major rivers or dams near the site**
 - Stream or dam breach flooding not expected to affect the site
- **No ice-jam flooding or flooding due to shoreline erosion**
- **Potential flooding from local PMP (Probable Maximum Precipitation)**
 - Site will be built up to higher elevation
 - Local drainage to drain away from safety-related structures
- **Potential flooding from storm surges and tsunamis**

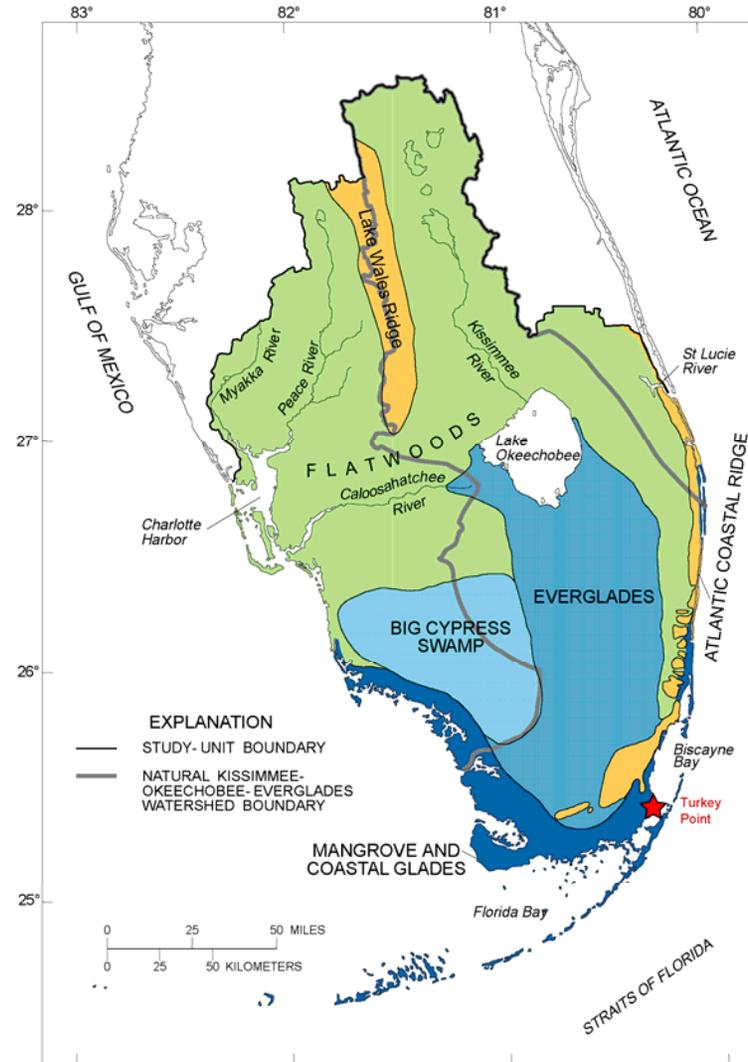
Hydrologic Description (continued)

South Florida Watershed Sub-Region



Hydrologic Description (continued)

Physiographic Features of South Florida Watershed

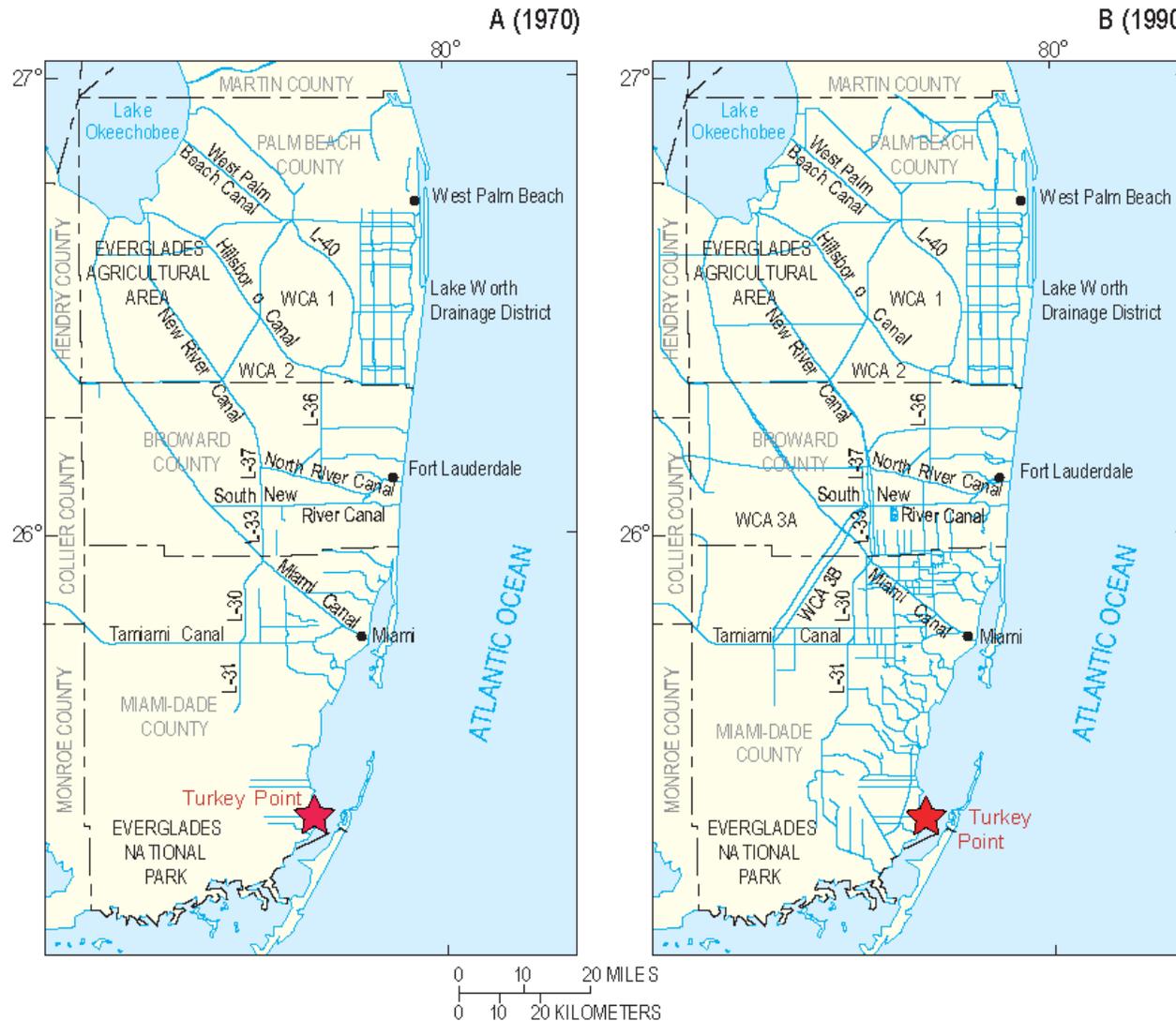


Base from U.S. Geological Survey digital data, 1:2,000,000, 1972
Albers Equal-Area Conic projection
Standard Parallels 29°30' and 45°30' central meridian -83°00'

Reference: USGS 1997

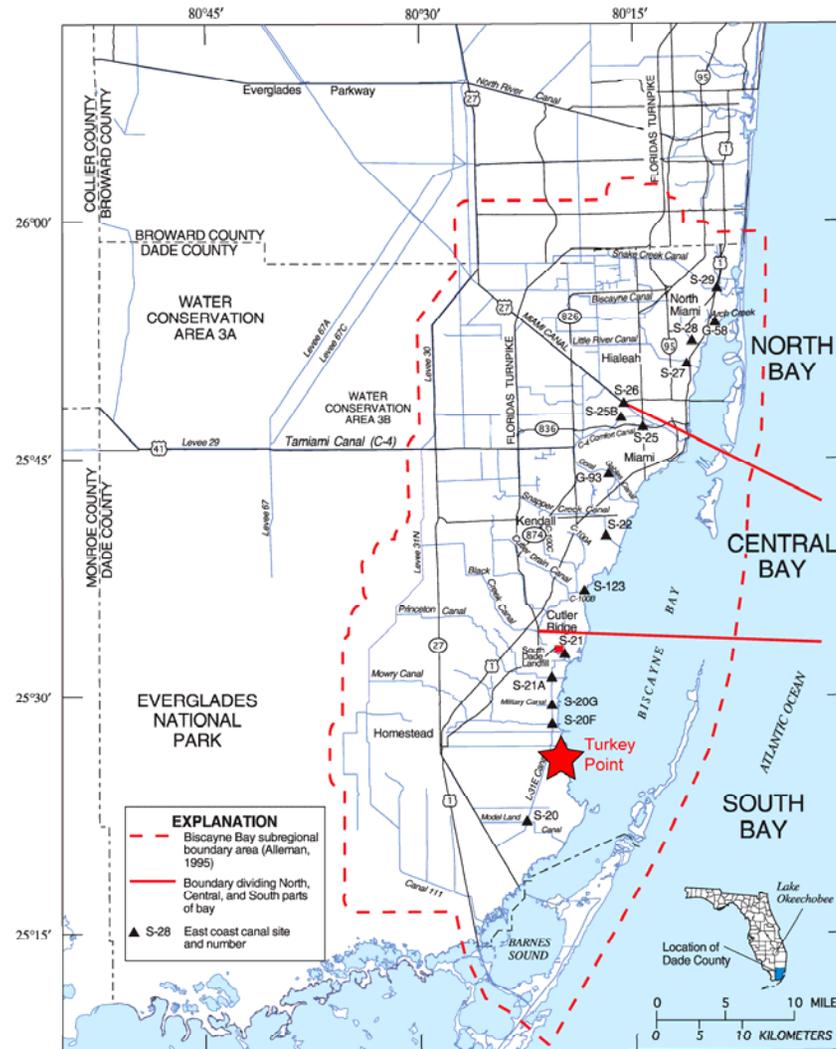
Hydrologic Description (continued)

Development of South-Dade Conveyance System



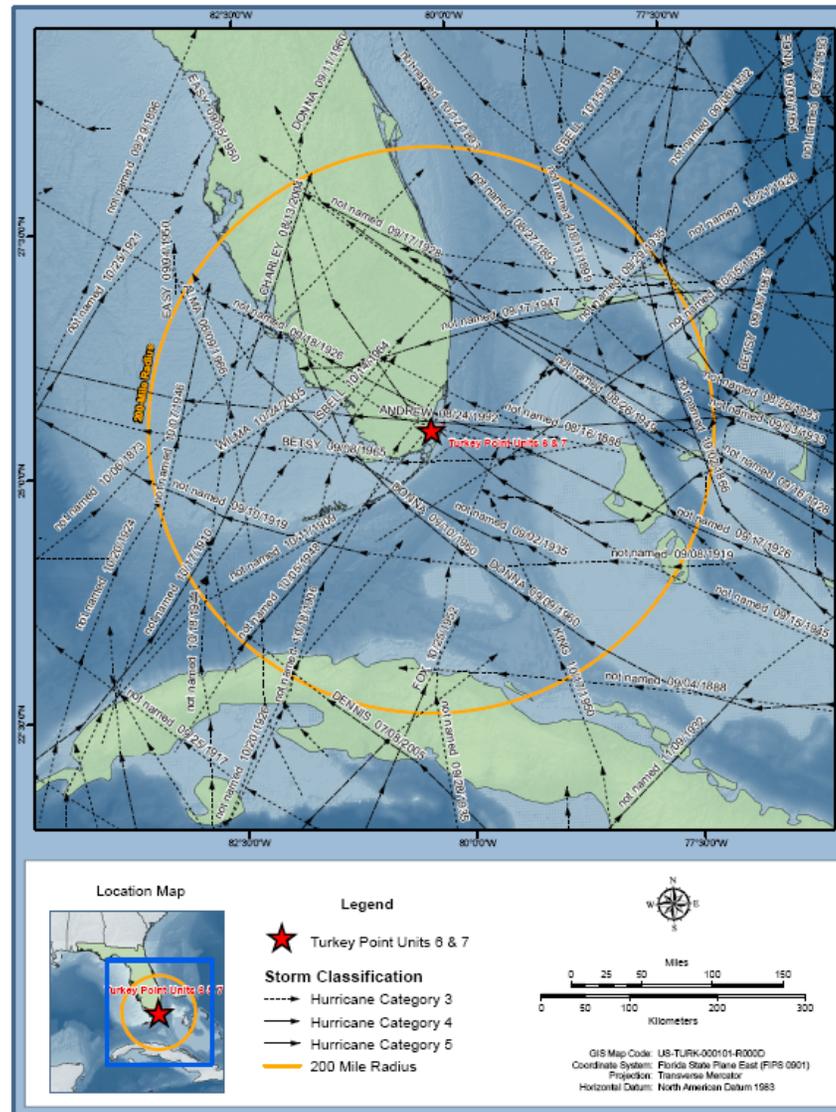
Hydrologic Description (continued)

Conveyance Canals and Control Structures



Probable Maximum Surge and Seiche Flooding

Hurricanes, Category 3 and Above, near the Site



Probable Maximum Surge and Seiche Flooding (continued)

Probable Maximum Hurricane (PMH)

- **Parameters are based on NOAA Report NWS-23**
 - Site is approximately at milepost 1450 nautical miles from U.S.-Mexico border

PMH Parameter	Magnitude
Peripheral Pressure	30.12 inch Hg
Central Pressure	26.12 inch Hg
Radius of Max. Wind	4 to 20 NM
Forward Speed	6 to 20 knots
Track Direction (clockwise from north)	72 to 185 deg
Inflow angle	2 to 9 deg

The PMH central and peripheral pressure difference is 4.0 inch Hg, which is approximately 135.5 millibars

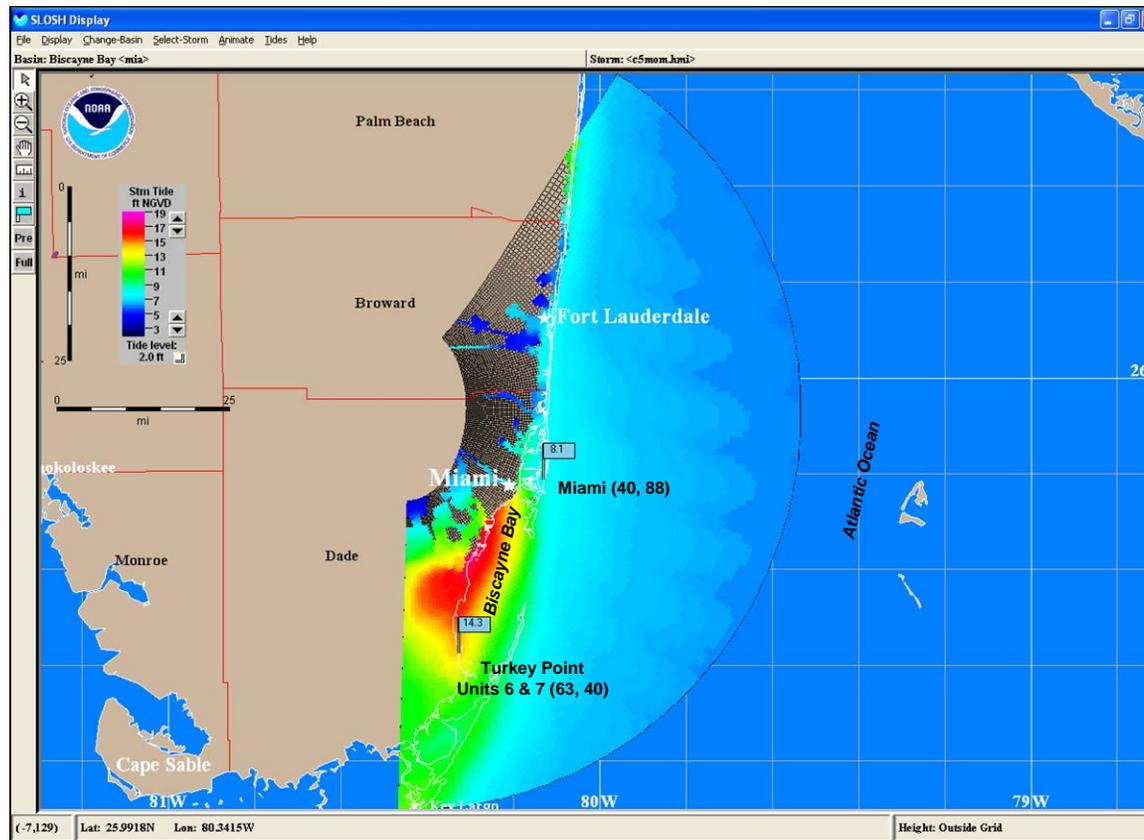
Probable Maximum Surge and Seiche Flooding (continued)

Probable Maximum Storm Surge

- **PMH-induced surge height**
 - Estimated based on two approaches
 - Projection of existing SLOSH computer program results to PMH conditions
 - Run SLOSH for the PMH and antecedent water level
- **10% exceedance high spring tide**
 - Conservatively from RG 1.59
- **Initial rise**
 - Conservatively from RG 1.59
- **Long-term sea level rise considered**

Probable Maximum Surge and Seiche Flooding (continued)

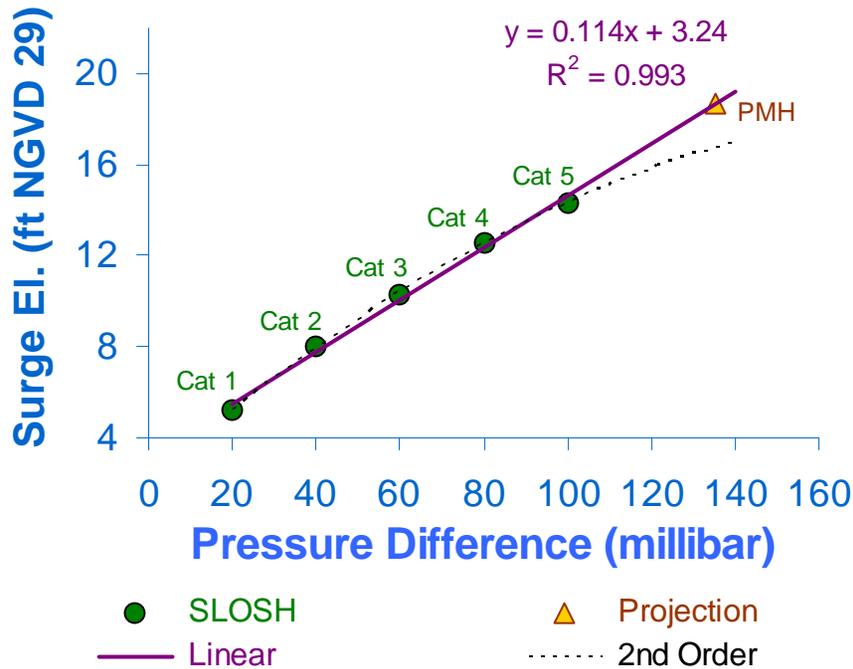
PMH Surge Height from SLOSH Results Projection



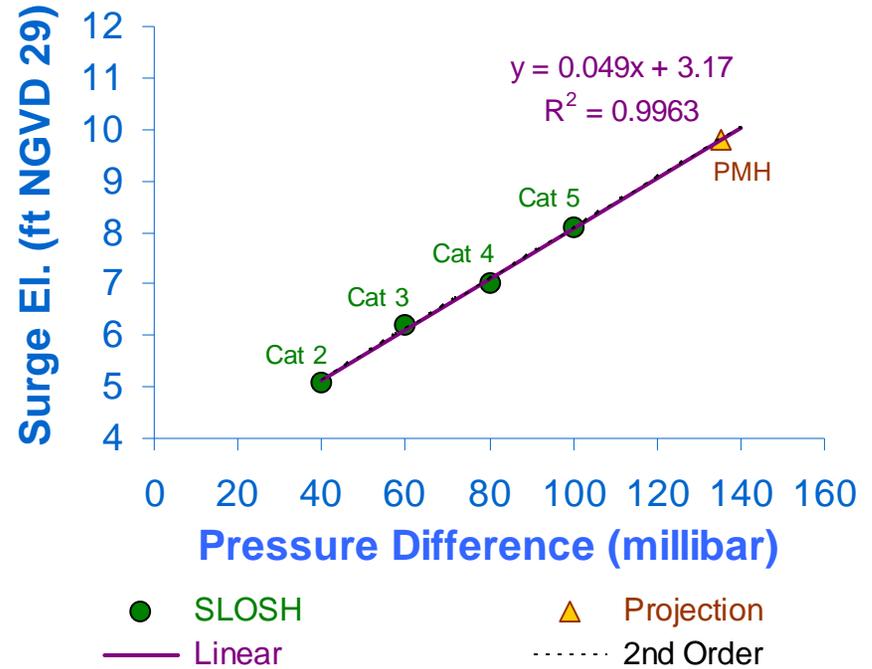
Results from SLOSH Biscayne Bay Basin Model for Hurricane Categories 1 through 5 (Saffir-Simpson scale), Category 5 MOM is shown above

Probable Maximum Surge and Seiche Flooding (continued)

Surge Projection at the Site, SLOSH Grid (63, 40)



Surge Projection near Miami, SLOSH Grid (40, 88)



The projected surge elevation for the PMH at the site is approximately 18.7 ft National Geodetic Vertical Datum NGVD 29, which is approximately 17.2 ft NAVD 88

Probable Maximum Surge and Seiche Flooding (continued)

Antecedent Water Level Conditions

- **Initial water level in SLOSH is 2 ft NGVD 29 (~ 0.5 ft NAVD 88)**
- **10% exceedance high spring tide in RG 1.59**
 - 3.6 ft MLW at Miami Harbor Entrance
- **Initial rise**
 - 0.9 ft MLW at Miami Harbor Entrance
- **10% Exceedance tide + Initial rise = 4.5 ft MLW (mean low water)**
 - Which is ~ 2.6 ft NAVD 88
- **Long-term sea level rise**
 - 0.78 ft/century at the NOAA Miami Beach, Florida station
 - Nominally used 1.0 ft/century (~ 25% increase from current trend)

Probable Maximum Surge and Seiche Flooding (continued)

PMSS Still Water Level and PMH Wind Speed

- **Adjusted surge projection (PMSS)**
 - $[(17.2 - 0.5) + 2.6]$ ft NAVD 88 + 1.0 ft = 20.3 ft NAVD 88
- **PMH-induced maximum wind speed**
 - Wind speeds estimated based on the methodology in NWS-23
 - Maximum stationary wind speed estimated
 - Maximum hurricane wind speed for moving hurricane for the range of PMH parameters
 - Resulting maximum wind speed (10-min average 33-ft high) at the site is 141 knots or ~ 162 miles per hour

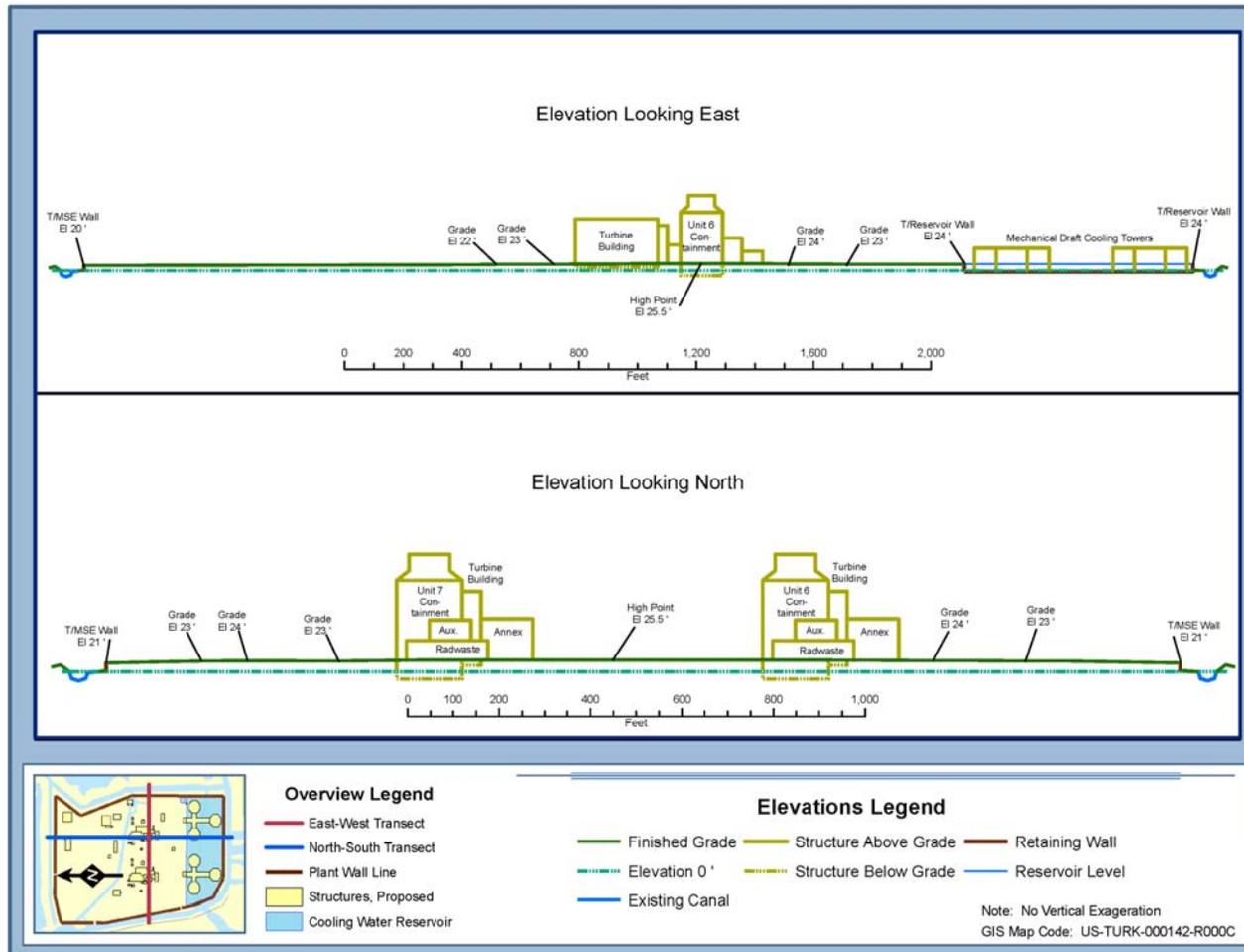
Probable Maximum Surge and Seiche Flooding (continued)

Wind Wave Effects and Maximum Water Level

- **Wave action**
 - Wave height governed by the breaking wave condition, limited by the water depth
 - Wave runup estimated based on methodology in the CEM
 - Resulting wave runup is 3.4 ft
- **Maximum water level due to PMSS**
 - $(20.3 \text{ ft NAVD } 88 + 3.4 \text{ ft}) = 23.7 \text{ ft NAVD } 88$

Probable Maximum Surge and Seiche Flooding (continued)

Site Grade Elevation



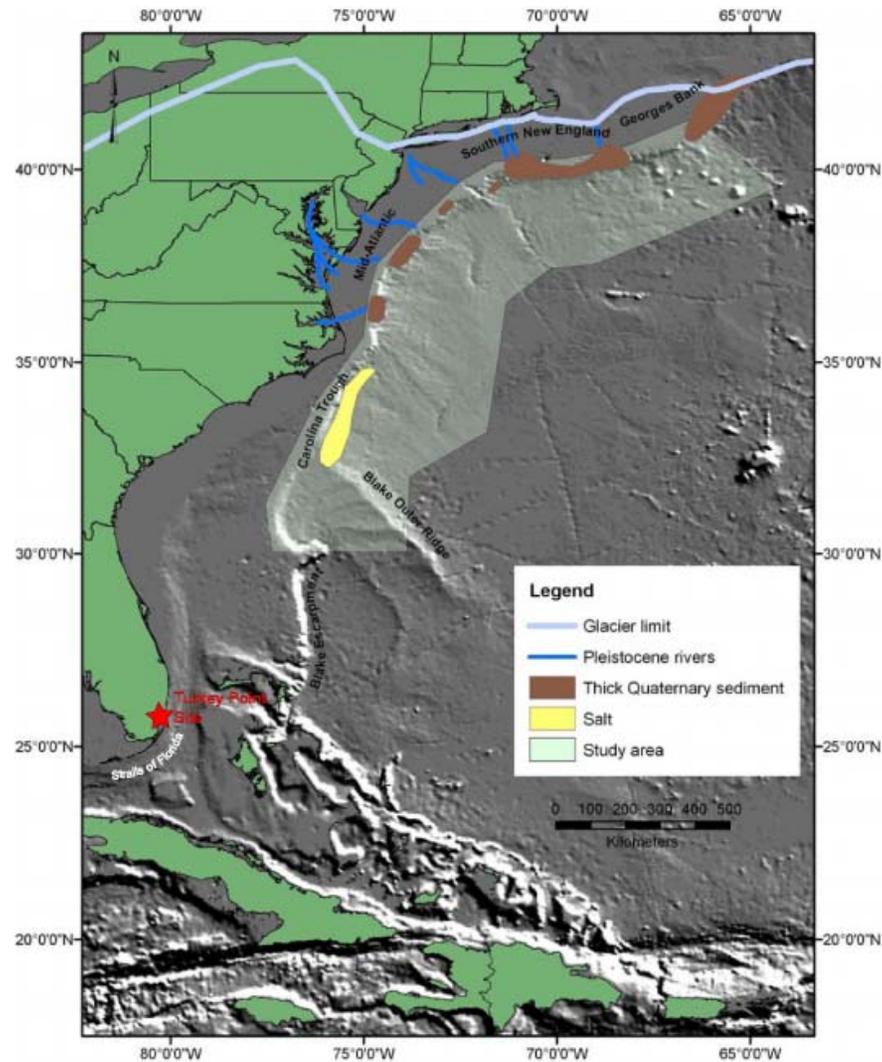
Probable Maximum Tsunami Hazards

Tsunami Source Mechanisms and Sources

- **Source identification based on National Geophysical Data Center (NGDC) Tsunami Database and published studies**
- **Source mechanisms include**
 - Submarine landslides
 - U.S. and Canada Atlantic margin
 - Gulf of Mexico
 - Earthquakes
 - Caribbean subduction zone
 - East Atlantic region (Azores-Gibraltar fracture zone)
 - Volcanic activities
 - Cumbre Vieja volcano in the Canary Islands of La Palma

Probable Maximum Tsunami Hazards (continued)

Landslide in the U.S. Atlantic Margin

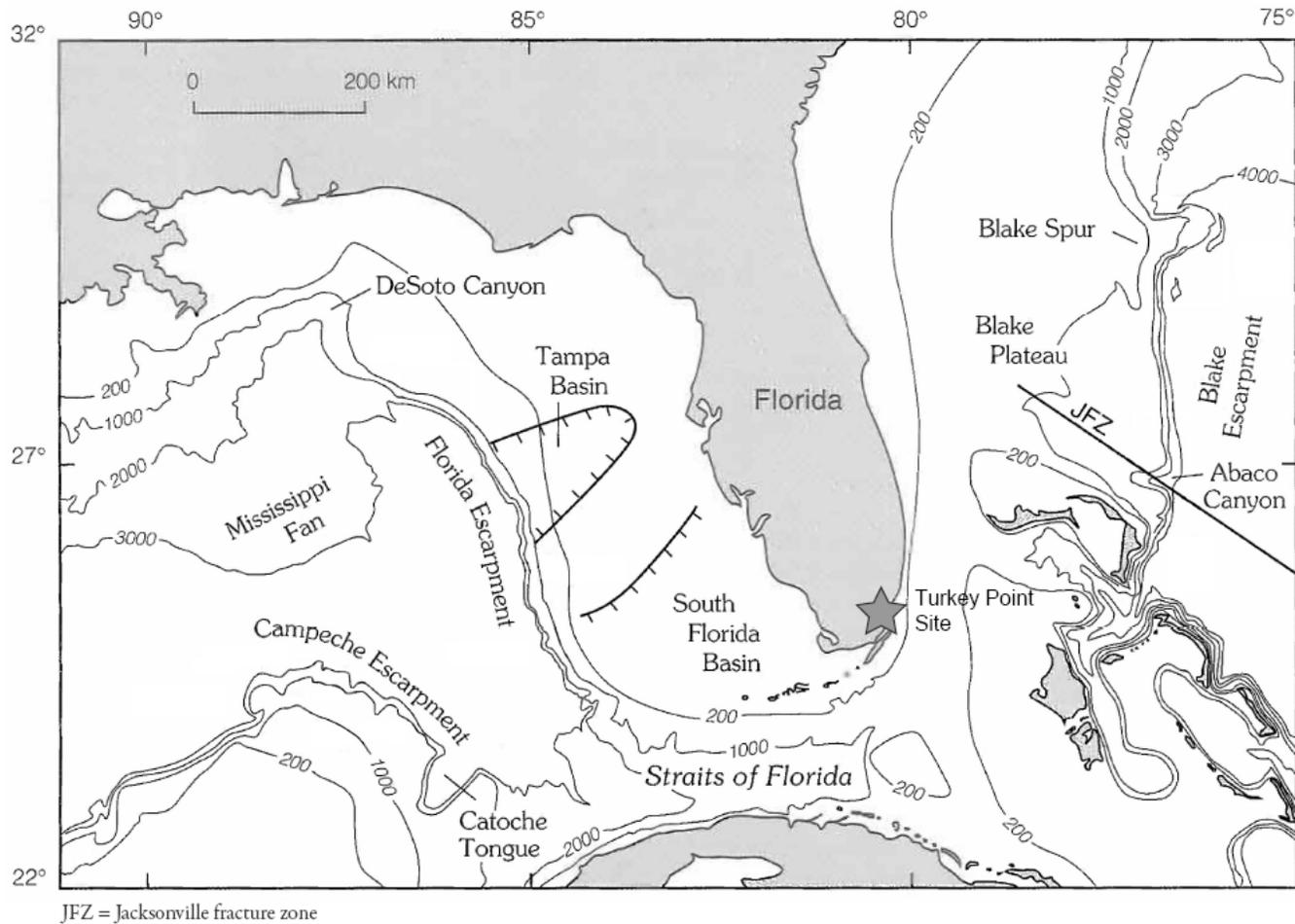


Note: Location of FPL Turkey Point Units 6 & 7 site is approximate.

Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

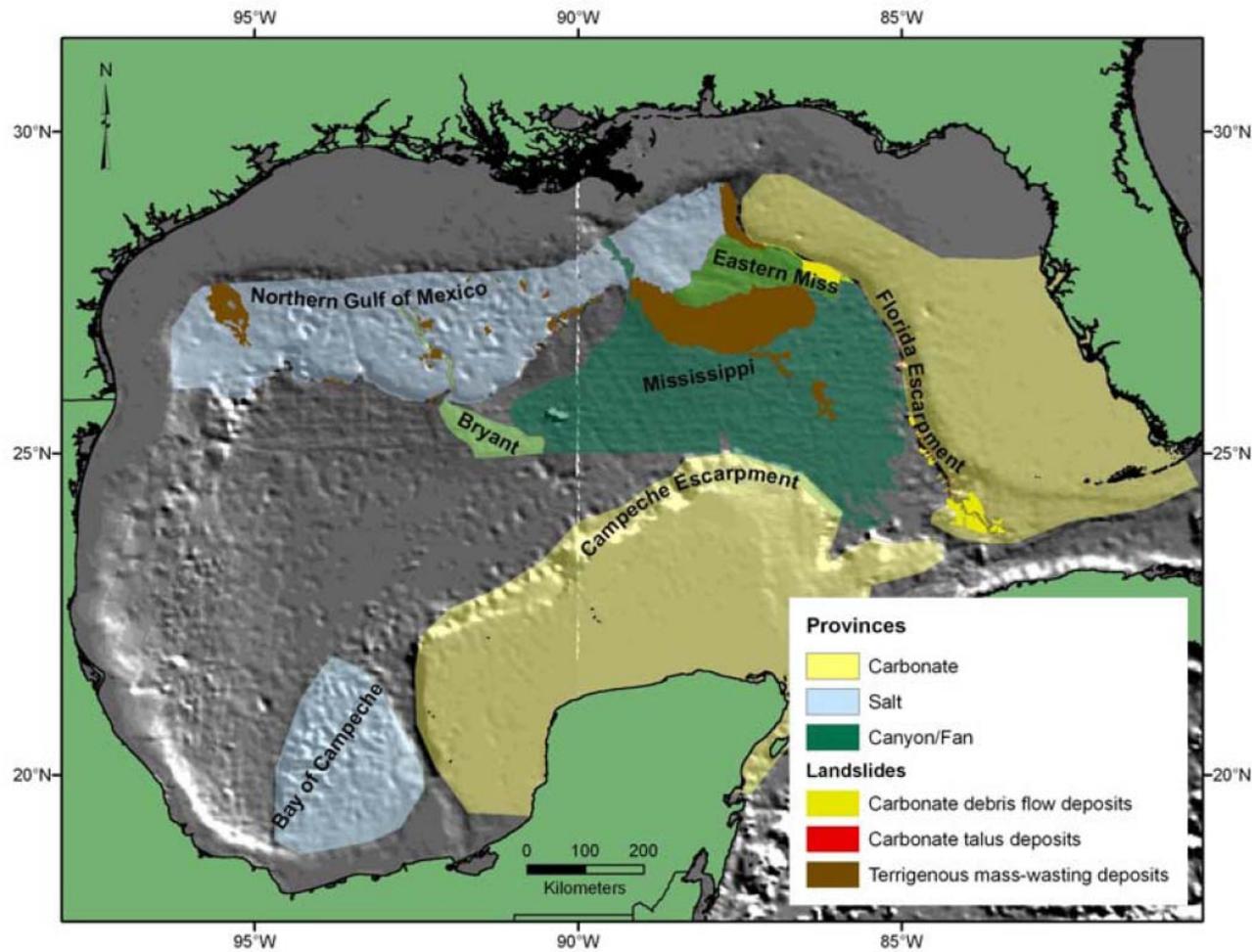
Landslide in Blake Escarpment



Reference: Twitchell et al. 1996

Probable Maximum Tsunami Hazards (continued)

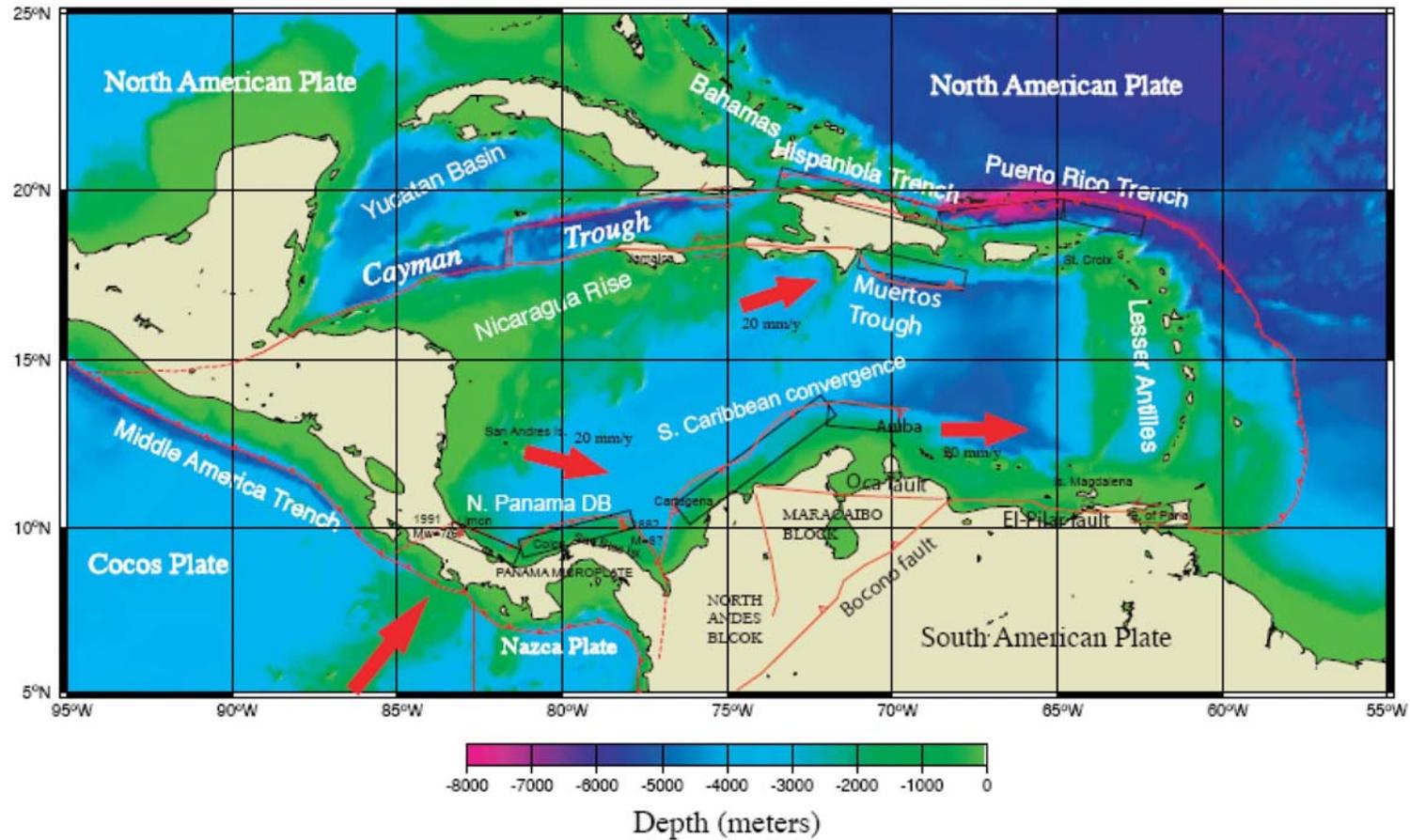
Submarine Landslide in Gulf of Mexico



Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

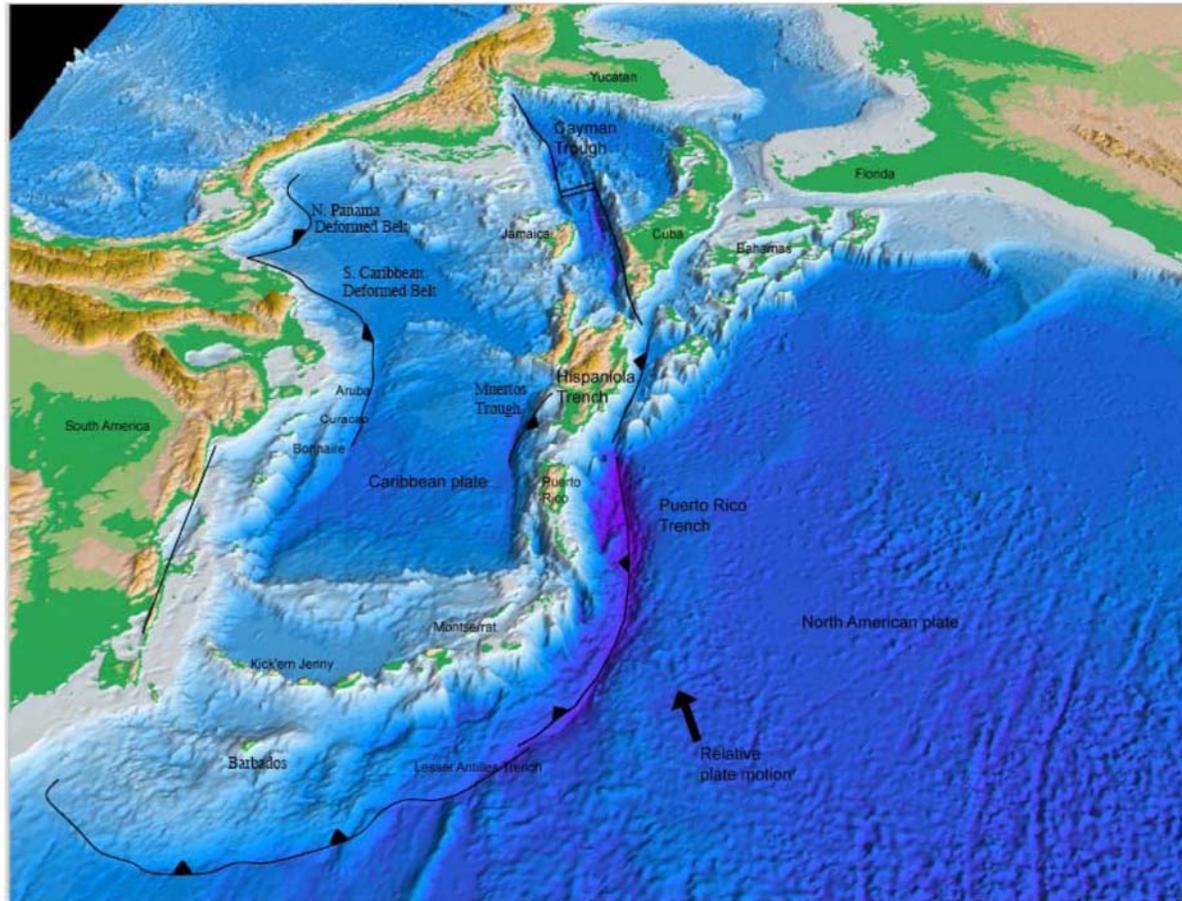
Caribbean Plate Boundary and Tectonic Elements



Note: red lines are plate boundaries and red arrows indicate relative plate movement
Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

Puerto Rico and Hispaniola Trenches



Reference: AGMTHAG 2007

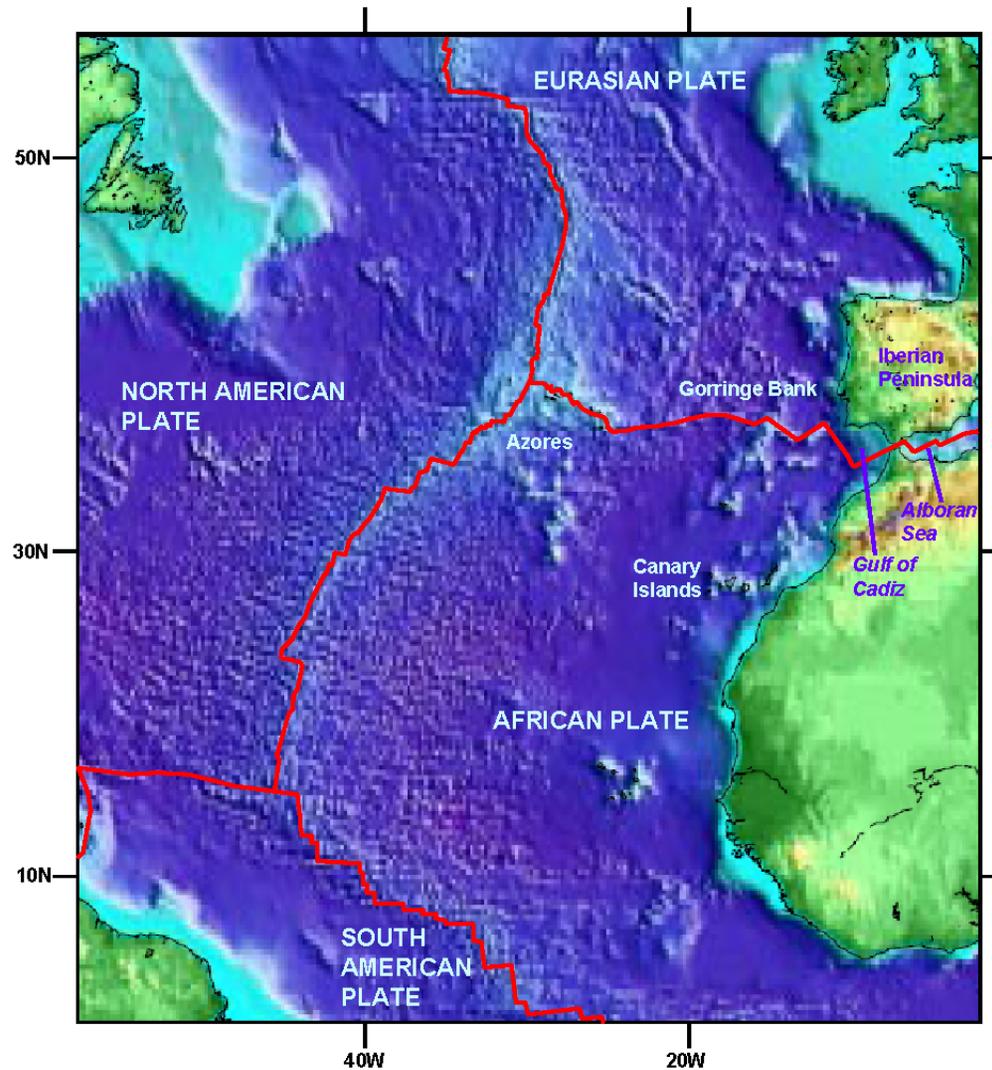
Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source

- **Earthquake sources in the Azores-Gibraltar Fracture Zone (the source for the 1755 Lisbon Earthquake)**
 - Two major views on plate tectonic summarized in AGMTHAG 2007
 - Strike-slip motion of plates
 - Fragmentation during Miocene with two narrow and active subduction zones
 - Primarily two source regions (AGMTHAG 2007)
 - Goringe Bank
 - Gulf of Cadiz
 - AGMTHAG (2007) provides characterization of both sources

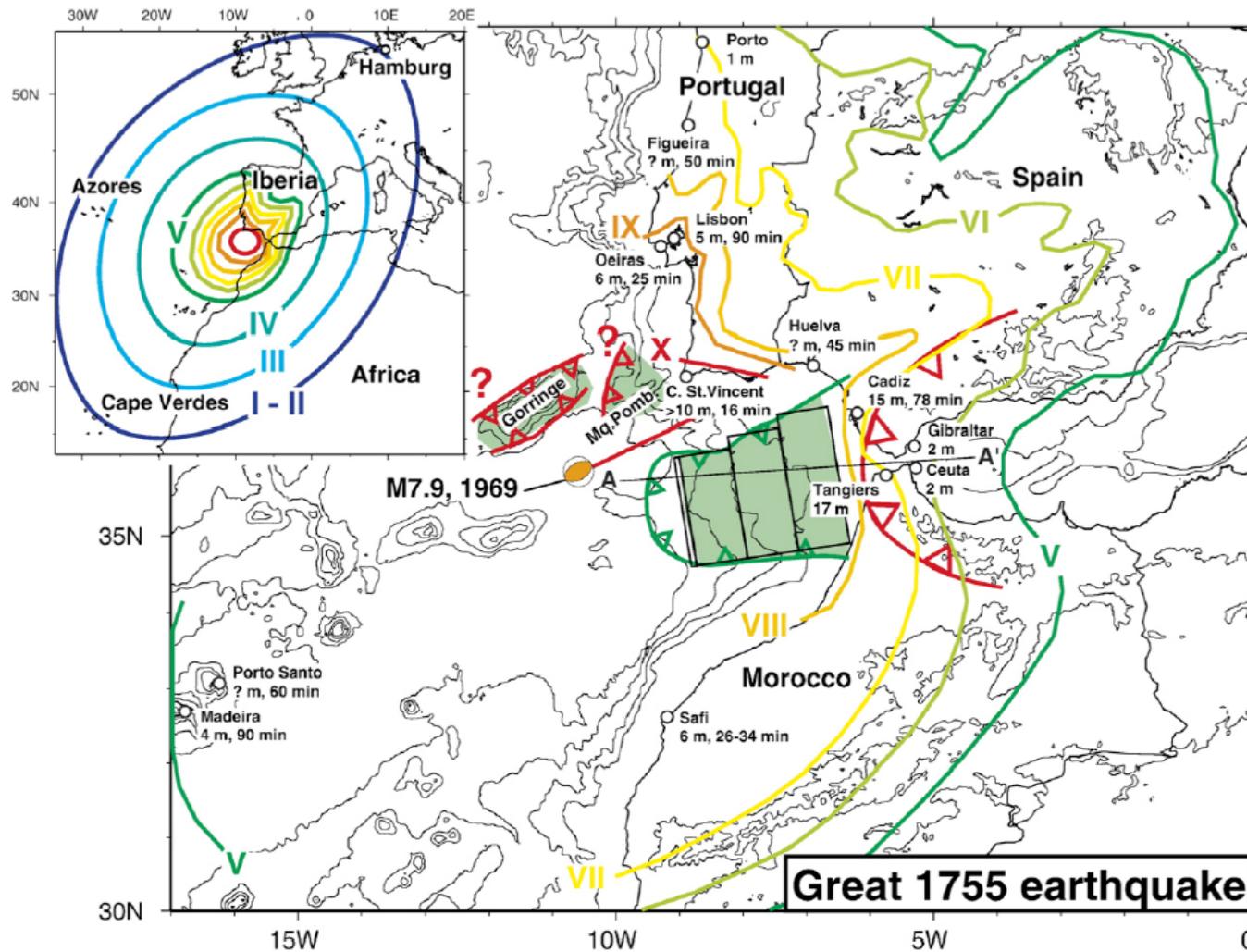
Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source (continued)



Probable Maximum Tsunami Hazards (continued)

PMT Candidate Source (continued)



Reference: AGMTHAG 2007

Probable Maximum Tsunami Hazards (continued)

Tsunami Water Level

- **Mader (2001) simulated the 1755 Lisbon tsunami to match known tsunami amplitudes in the Portugal coast and across the Atlantic Ocean**
- **PMT water level is taken from the simulation results of Mader (2001)**
 - 2 m (6.6 ft) amplitude at 783 m (~ 2570 ft) water depth east of Miami
 - Onshore tsunami amplitude including runup is 2 x deepwater amplitude = 4 m (13.1 ft)
 - Antecedent water level same as defined for storm surge, i.e., 2.6 ft NAVD 88 for 10% exceedance high spring tide and initial rise, and 1.0 ft/century for long-term sea level rise
 - The maximum tsunami water level near the site is (13.1 ft + 2.6 ft NAVD 88 + 1.0 ft) = 16.7 ft NAVD 88

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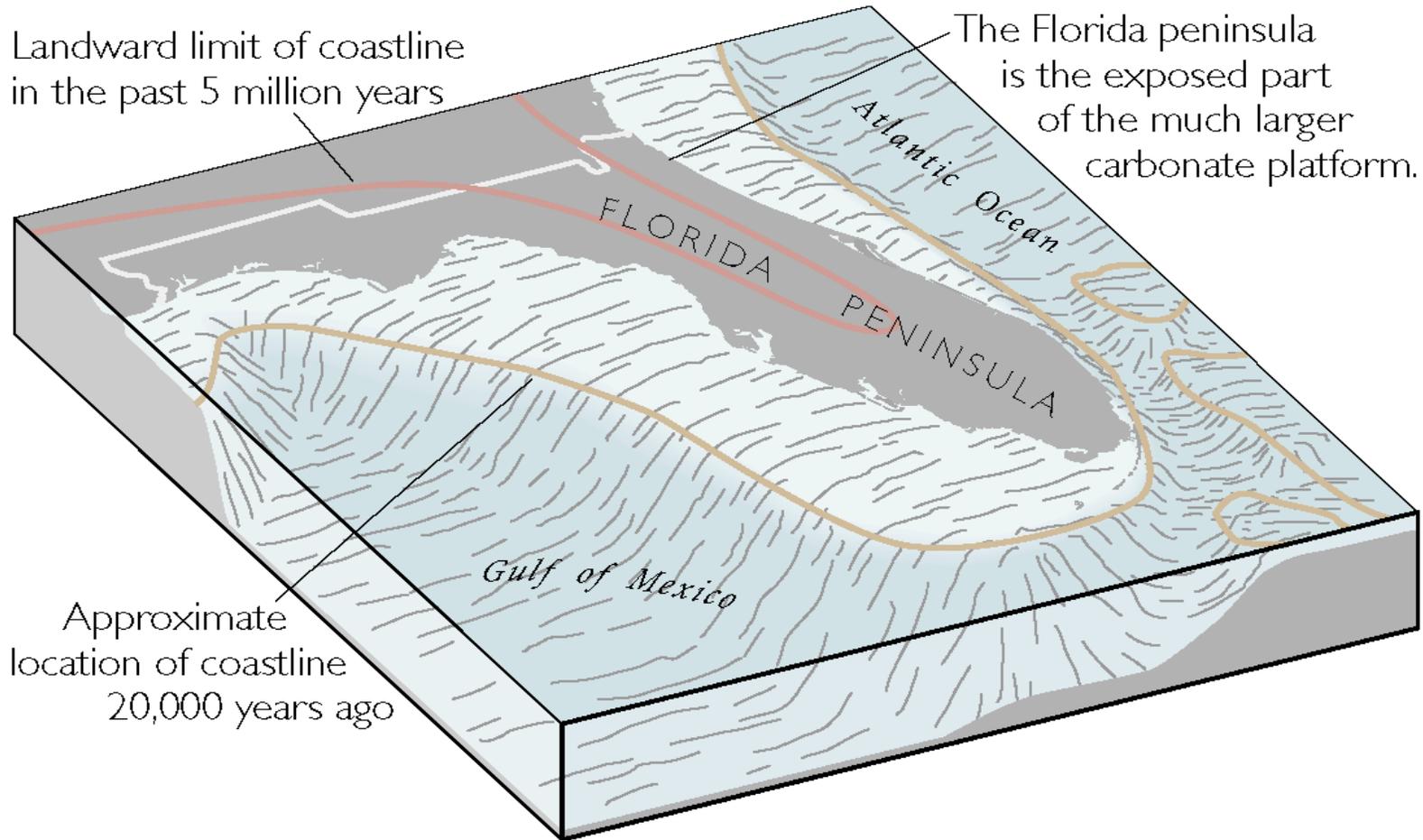
General Geologic Conditions

Dave Fenster

Engineering Geology Supervisor, Bechtel

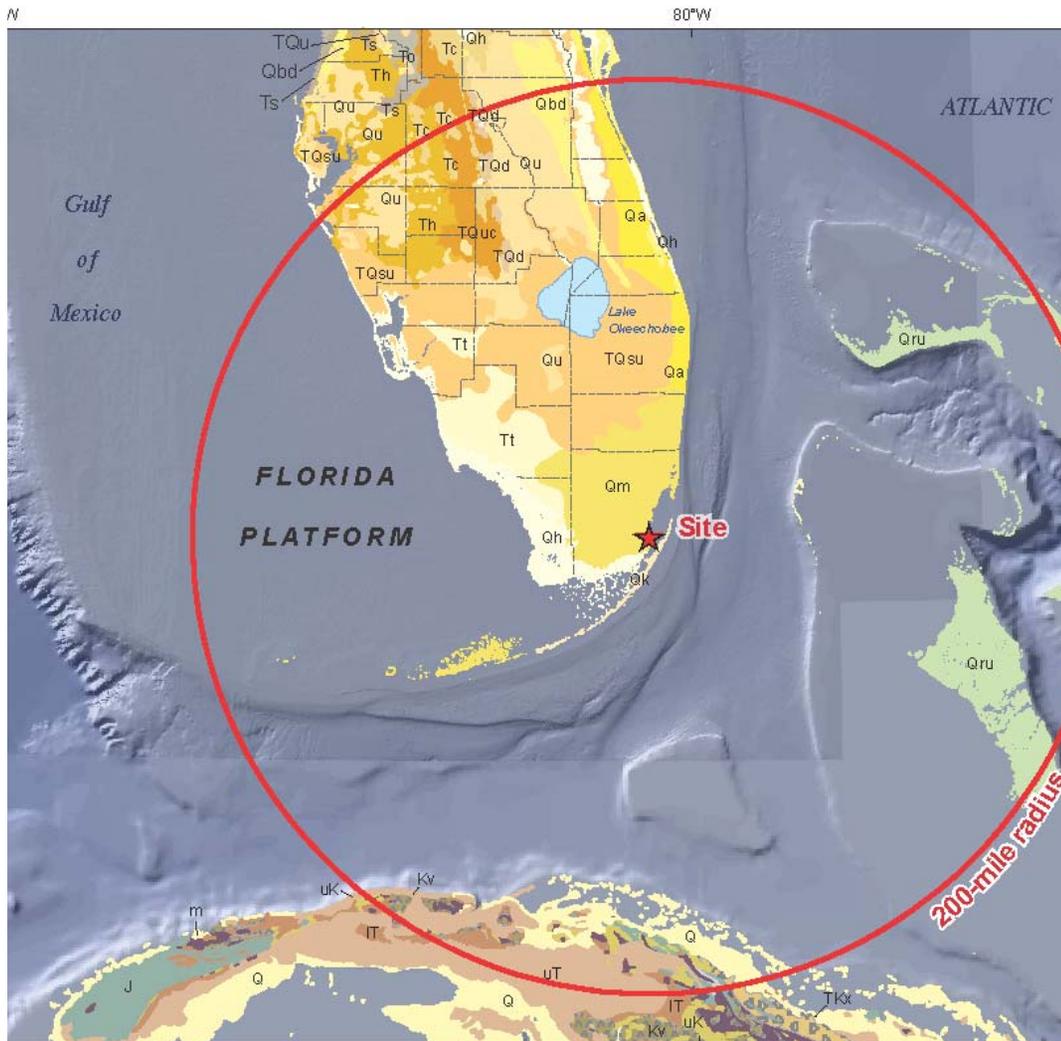
December 5, 2008

Florida Geomorphology



Source: Tihansky, A.B., 1999

Regional Geology



Florida Geologic Units

QUATERNARY	Qh	Holocene sediments	Qk	Key Largo Limestone	Qm	Miami Limestone
	Qa	Anastasia Formation				
	Qdb	Beach Ridge and Dune deposits				
	Qu	Undifferentiated sediments				
LATE TERTIARY/ EARLY QUATERNARY	TQsu	Shelly sediments (includes Fort Thompson, Bermont, and Caloostahatchee Formations)				
	TQuc	Reworked Cypresshead sediments				
	TQd	Dune deposits				
	TQu	Undifferentiated sediments				
TERTIARY	Tc	Cypresshead Formation				
	Tt	Tamiarni Formation				
	Th	Hawthorn Group, undivided				
	Ts	Suwannee Limestone				
	To	Ocala Limestone				

BODC, 2008; Scott, et al, 2001



Paleozoic & Mesozoic Regional Stratigraphic Column

ERA	SYSTEM	SERIES	STRATIGRAPHIC UNIT	LITHOLOGY	THICKNESS (ft)	
MESOZOIC	CRETACEOUS	UPPER	Pine Key Formation	chalk, ls, dol	3000	
		LOWER	Naples Bay Group	Corkscrew Swamp Fm	ls with anhyd & dol	450
				Rookery Bay Fm		500
				Panther Camp Fm		350
			Big Cypress Group	Dollar Bay Fm	ls w. dol & anhyd	450-620
				Gordon Pass Fm	anhyd w. ls & dol	475
				Marco Junction Fm	ls w. dol & anhyd	350
			Ocean Reef Group	Rattlesnake Hammock Fm	anhyd w. ls & dol	600
				Lake Trafford Fm	ls with anhyd	150
				Suniland Fm	ls with dol & anhyd	200-300
			Glades Group	Punta Gorda Anhydrite	salt with anhyd & dol	800
					Lehigh Acres Formation	anhyd with ls, dol, sh
				anhyd, ls, dol		210
				ls, dol, brown dol zone		300
	sh	200				
	Pumpkin Bay Formation	anhyd with ls	1200			
	Bone Island Formation	ls with anhyd & dol	1300-2000			
	JURASSIC	UPPER	Wood River Formation	dol, anhyd, salt, ss	1700-2100	
		MIDDLE	basement volcanic province	felsic rocks: rhyolite porphyry		
		LOWER		mafic volcanics: basalt & diabase		
PALEOZOIC			Suwanee terrane	Paleozoic sedimentary Suite	quartzitic sandstone & black shale	
				Osceola volcanic complex	felsic meta-igneous	
				Osceola Granite	granite	
				St. Lucie Metamorphic Complex	pan-African metamorphics	
TOTAL THICKNESS					12,750-14,300	

Developed from selected references including:

Arthur, 1988; Dallmeyer, 1989; Pollastro, et al, 2001; Salvador, 1991; Winston 1987.

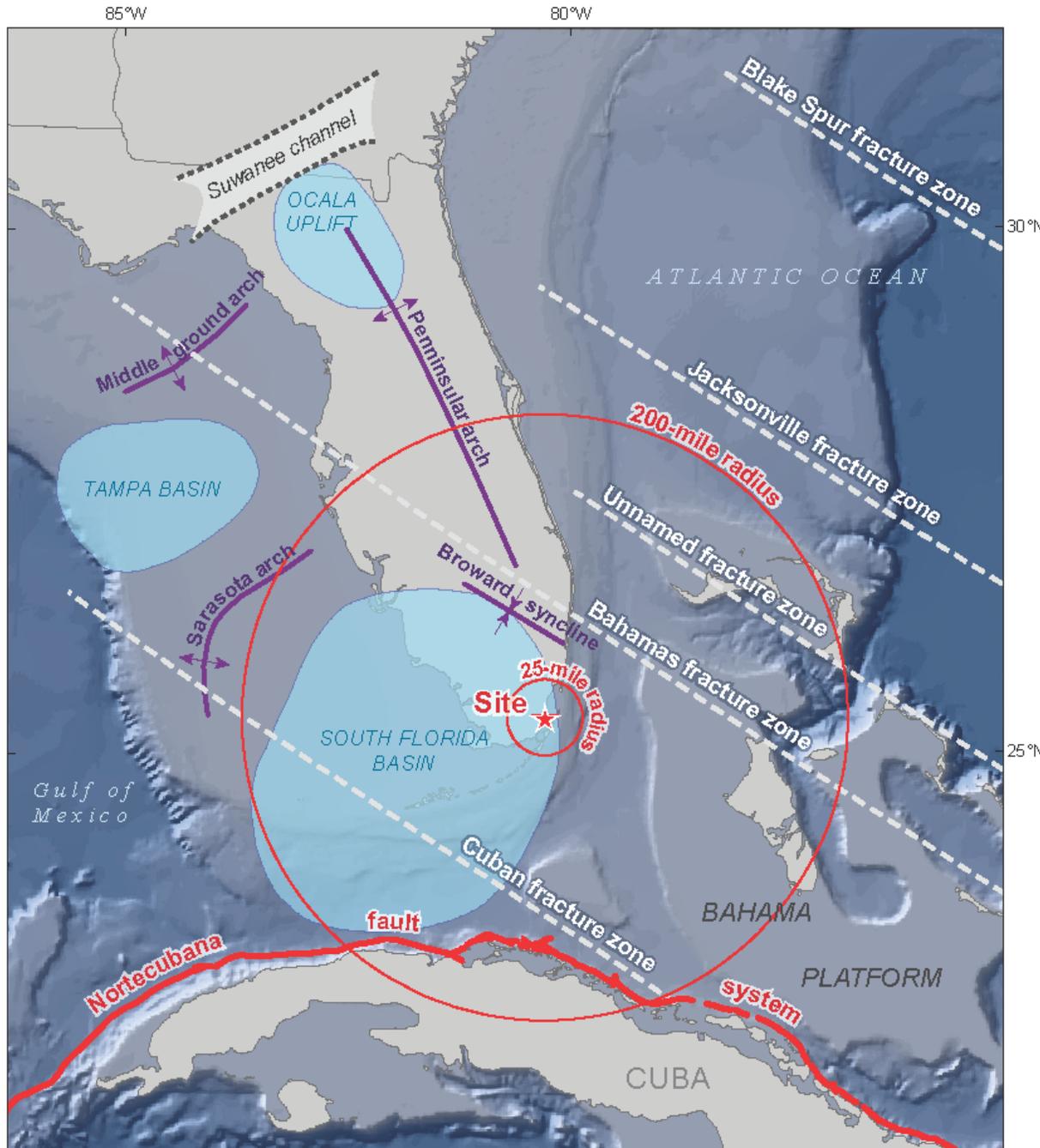
Cenozoic Regional Stratigraphic Column

ERA	SYSTEM	SERIES	STRATIGRAPHIC UNIT	LITHOLOGY	THICKNESS (ft)	
CENOZOIC	QUATERNARY	PLEISTOCENE	Miami Limestone / Key Largo Limestone/ Anastasia Formation	sandy, oolitic, corraline, shelly limestone	10-180	
			Caloosahatchee Formation/ Fort Thompson Formation	poor/well indurated sandy, fossiliferous limestone	50-100	
	NEOGENE	PLIOCENE	Tamiami Formation/ Cypresshead Formation (Long Key Formation)	fossiliferous sand & silt with limestone	25-220	
			MIOCENE	Hawthorn Group	Peace River Formation	sands, clays, & phosphatic carbonates
		Arcadia Formation			fine XTLn limestone with sand/clay, phosphatic fossiliferous limestone, & dolomite	100-700
		OLIGOCENE		Suwannee Limestone	poor/well indurated fossiliferous vuggy to moldic limestone	200-600
		TERTIARY	EOCENE	Ocala Limestone	poor/well indurated fossiliferous limestone	200-400
	Avon Park Formation			poor/well indurated fossiliferous limestone & vuggy dolostone	400-1200	
	Oldsmar Formation			vuggy limestone & dolomite	500-1500	
	PALEOCENE			Cedar Keys Formation	dolomite, gypsum, & anhydrite	500-2000
	TOTAL THICKNESS					5000-6000

Developed from selected references including:

Cunningham, et al, 1998; Halley, et al, 1997; Missimer, 2001; Reese, 1994; Reese & Richardson, 2008.

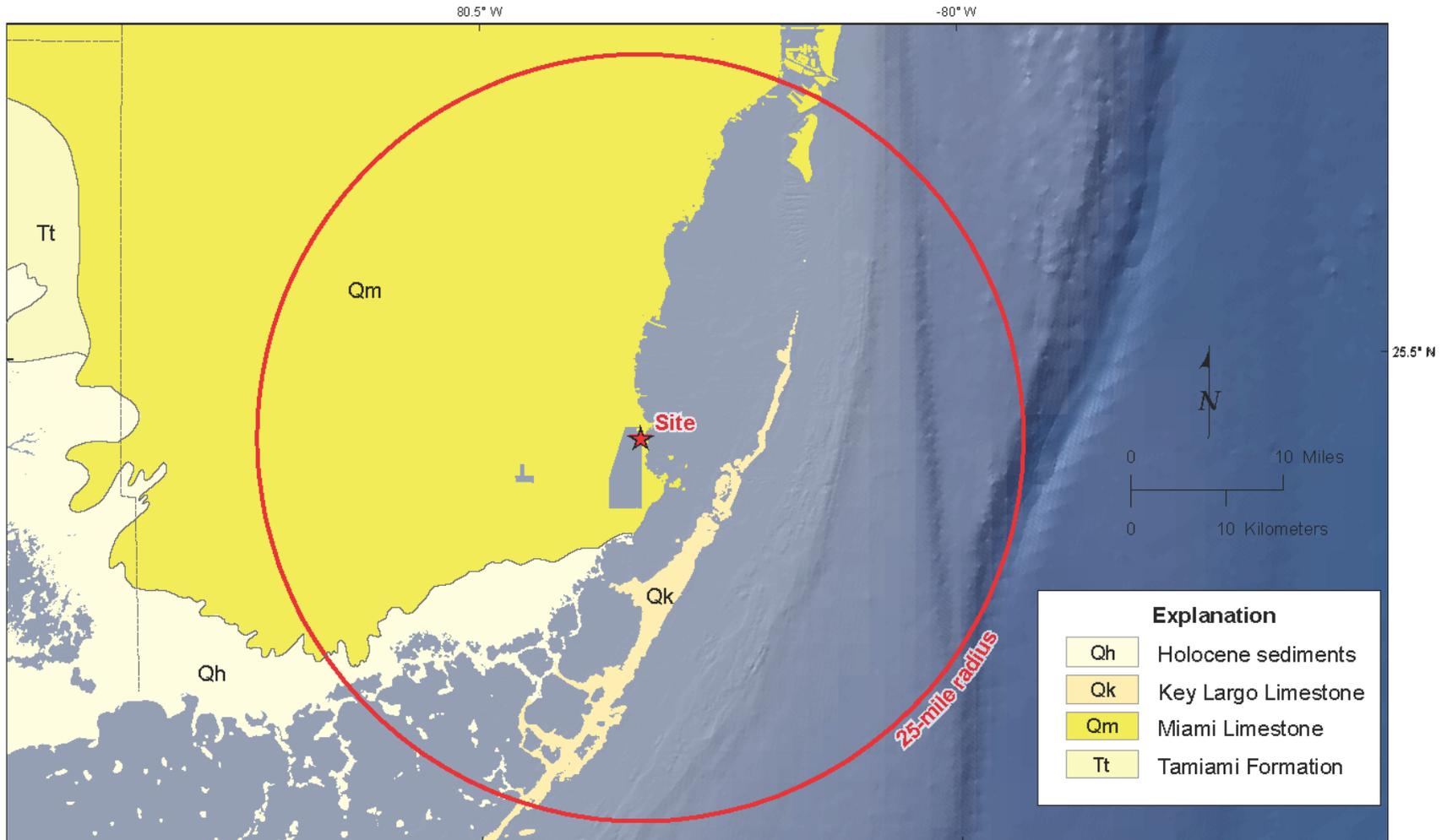




Regional Geologic Structure

BODC, 2008; Ewing & Lopez, 1991; French, et al, 2004.

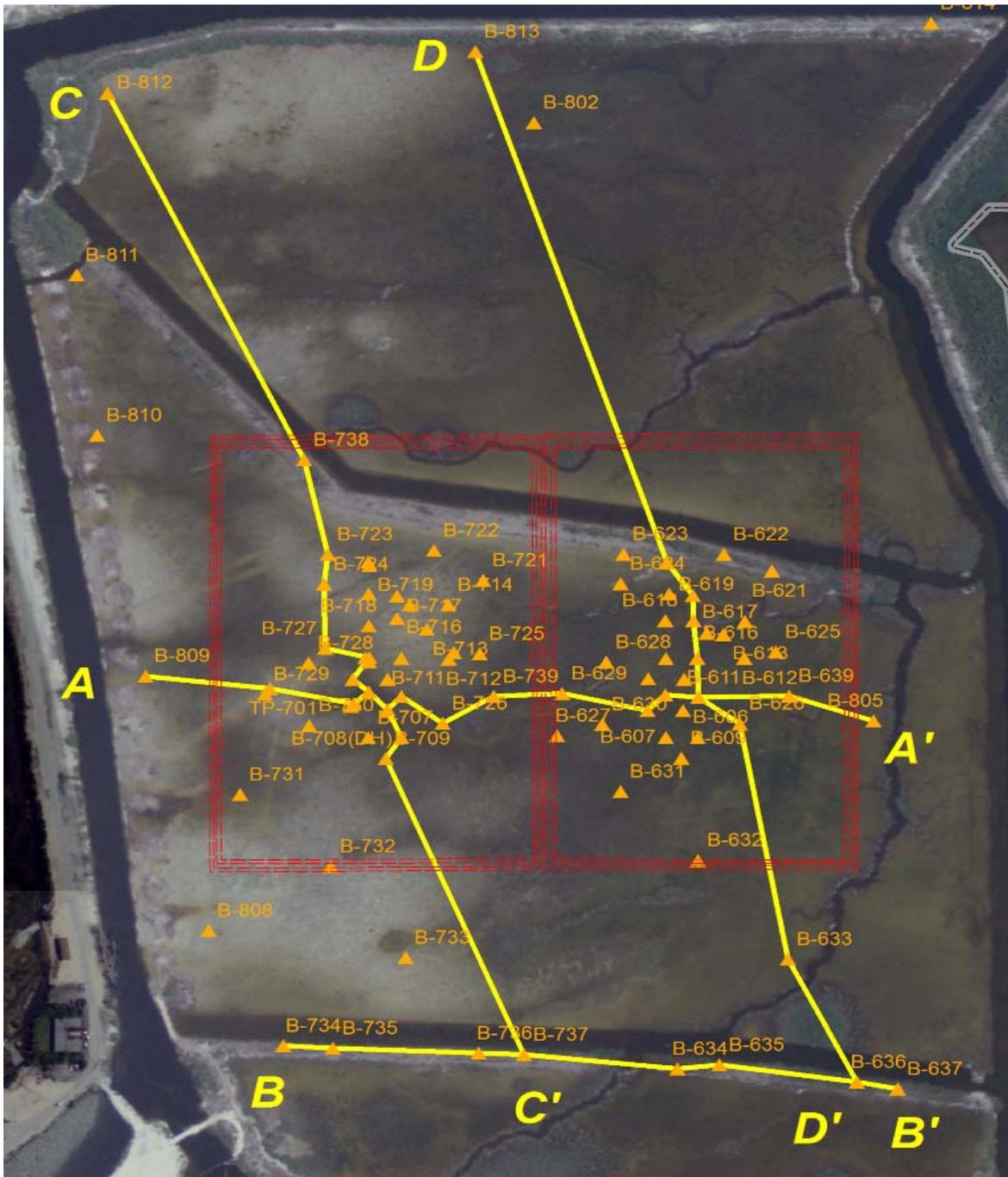
Site Geology & Structure



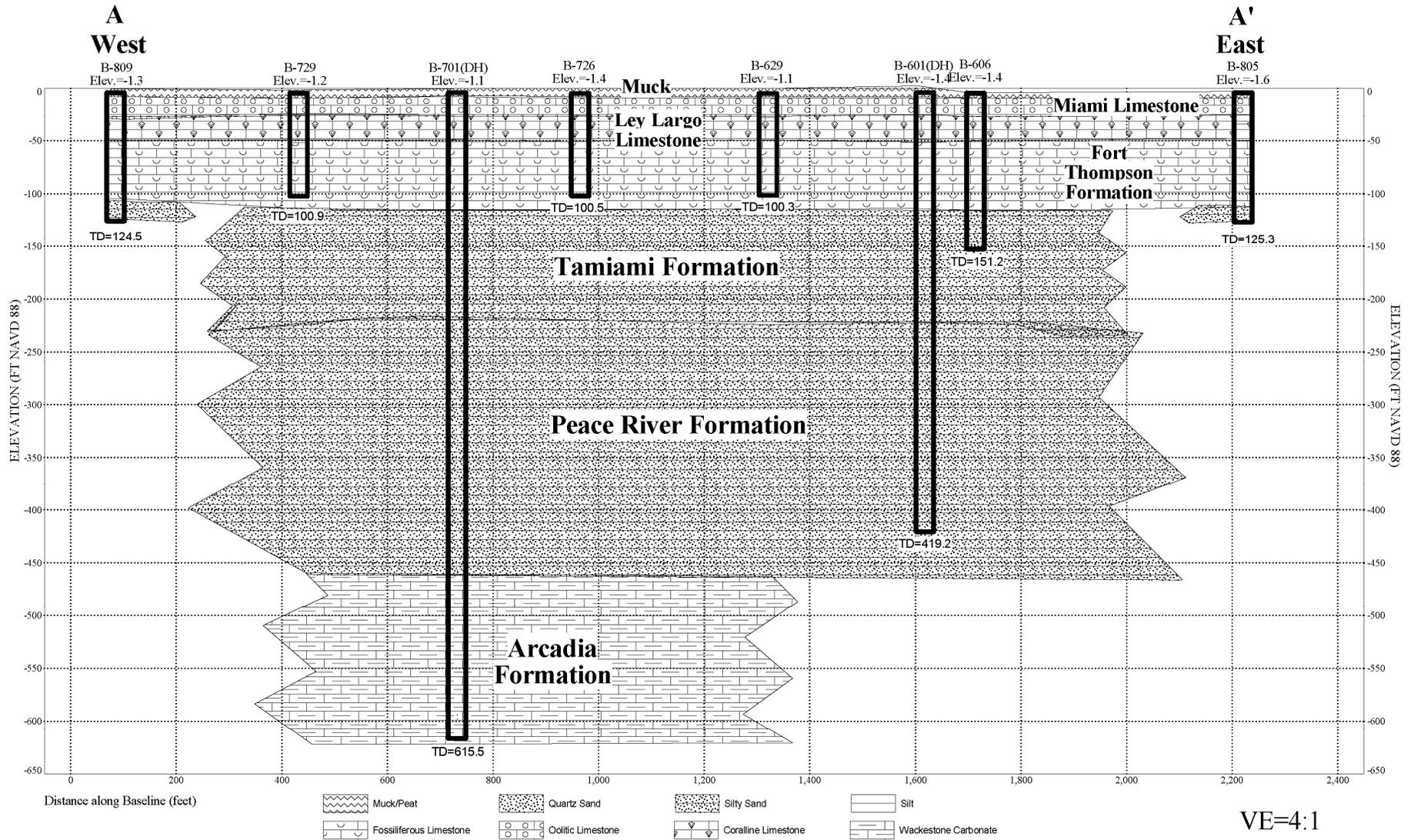
Site Subsurface Exploration



Site Boring & Cross-Section Locations



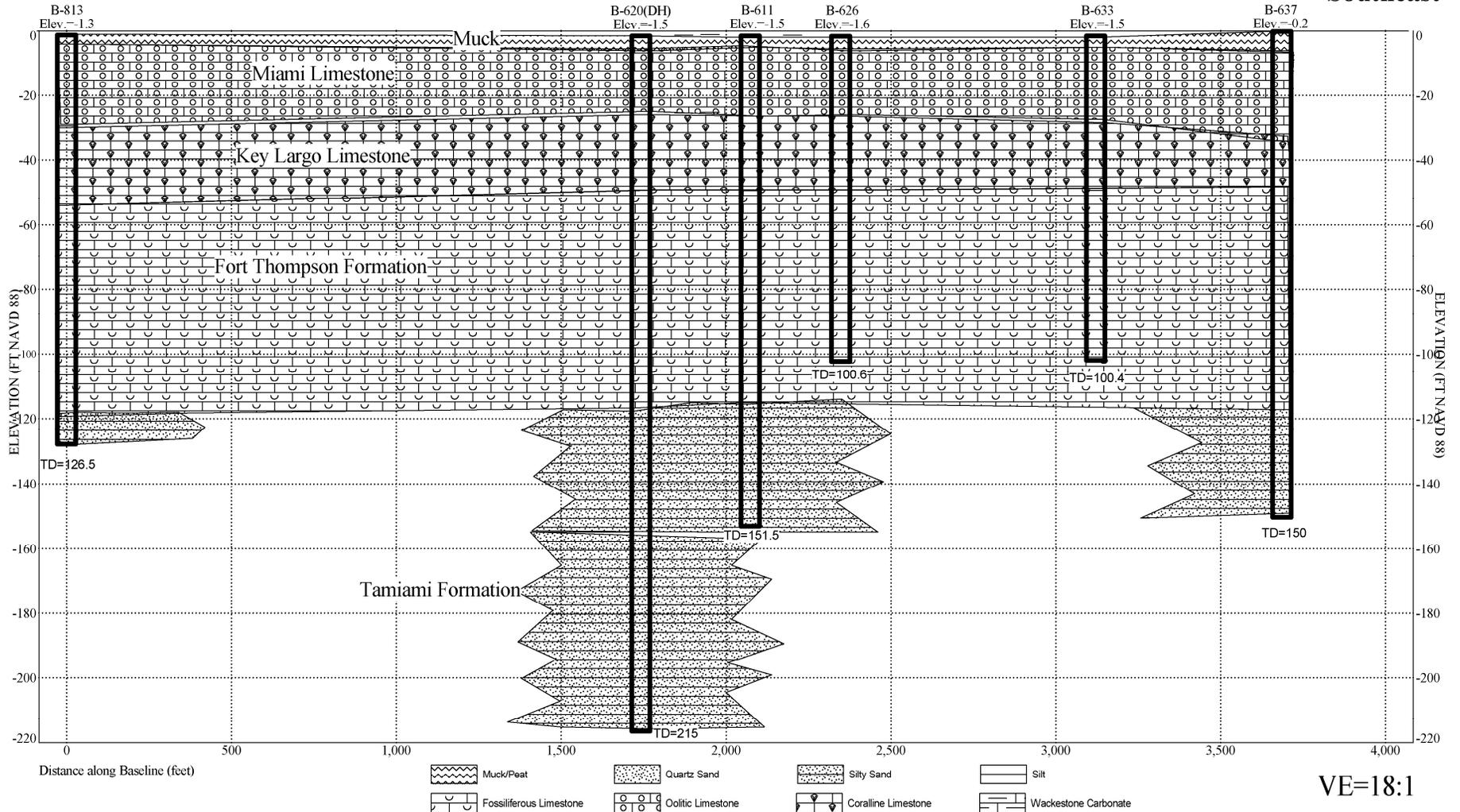
Geology Cross-Section A – A'



Geology Cross-Section D – D'

D
Northwest

D'
Southeast



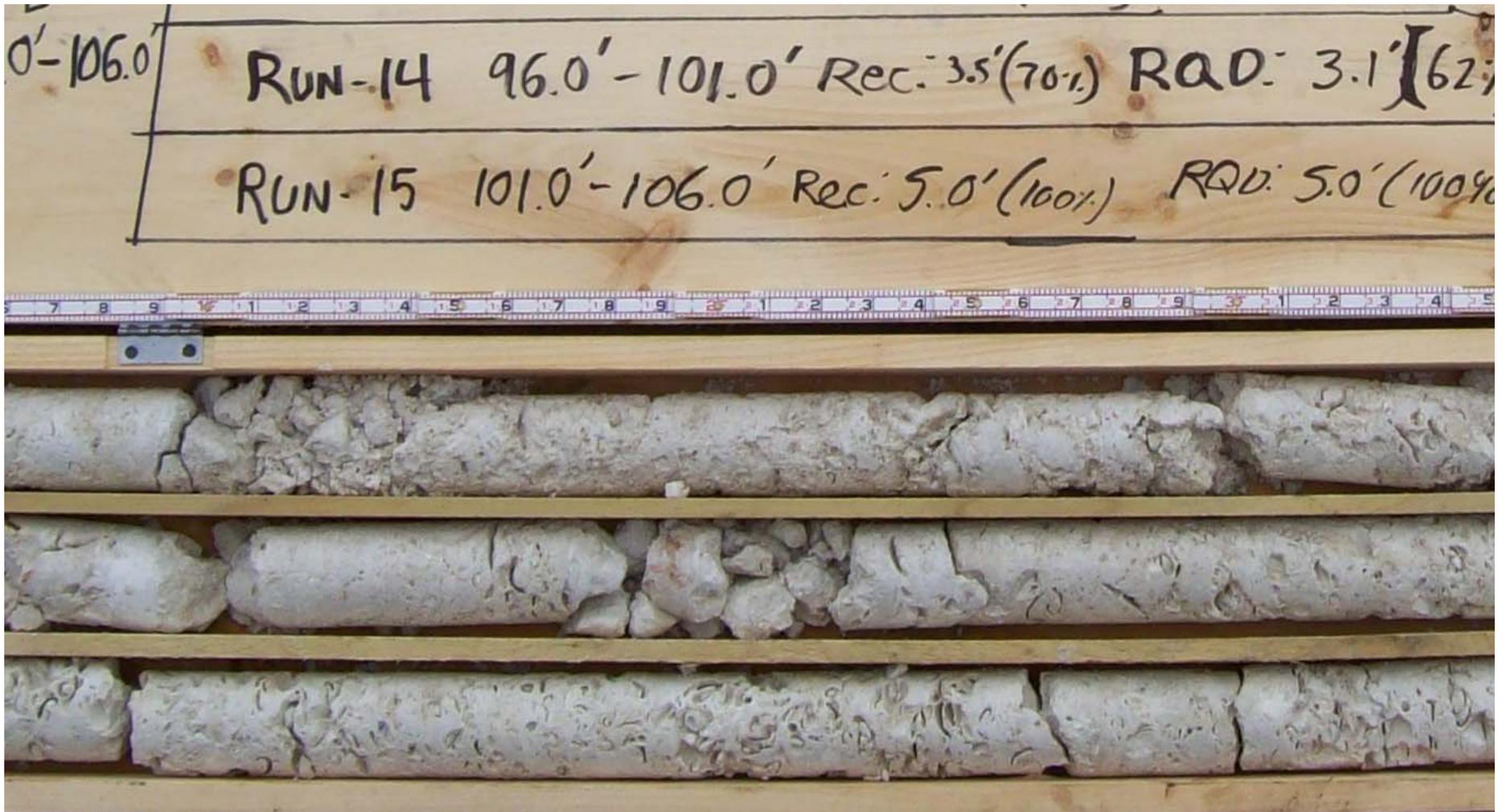
Key Largo Limestone Sample: 26-36 ft.



Fort Thompson Formation Sample: 51-66 ft



Fort Thompson Formation Sample: 91-106 ft



Site Stratigraphic Column

ERATHEM	SYSTEM	SERIES	HYDRO- GEOLOGIC UNIT	STRATIGRAPHIC UNIT	LITHOLOGY	TOP ELEVATION	THICKNESS (ft)	
CENEZOIC	QUATERNARY	HOLOCENE	Surficial aquifer system	Biscayne aquifer	organic muck	organic soil and silt	0	3
		PLEISTOCENE			Miami Limestone	sandy, oolitic limestone	-3	25
					Key Largo Limestone	well indurated, vuggy, coralline limestone	-28	22
					Fort Thompon Formation	poor/well indurated fossiliferous limestone	-50	65
	TERTIARY	PLIOCENE	Semi-confining unit	Tamiami Formation	sand and silt with calcarenitic limestone	-115	105	
		MIOCENE	Intermediate confining unit	Hawthorn Group	Peace River formation	silty calcareous sand and silt	-220	235
					Arcadia formation	calcareous wackestone with indurated limestones, sandstone, and sand	-456	>160
<i>drilling ended at -616 ft</i>								

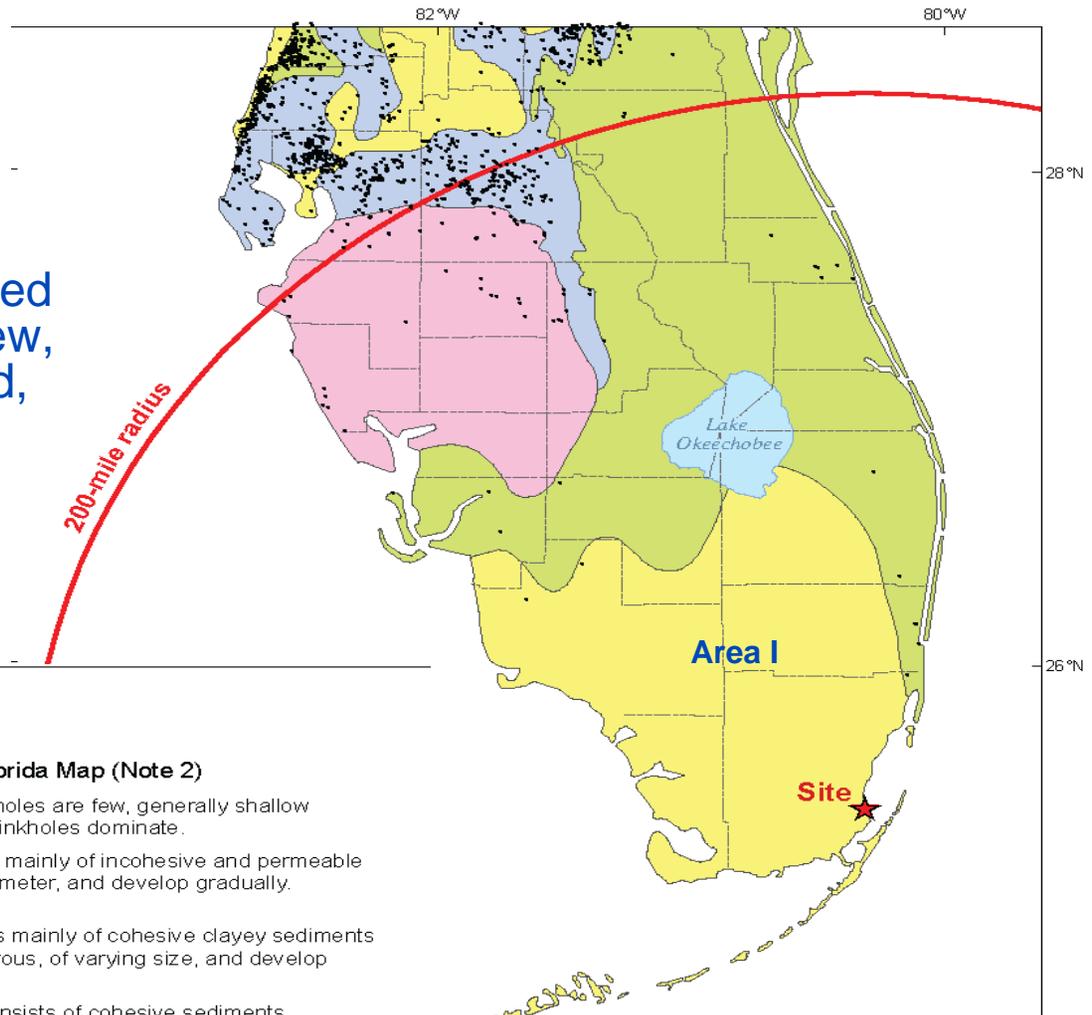
formation contact based on natural gamma signature

Florida Geological Survey Sinkhole Map

Area I: Bare or thinly covered limestone. Sinkholes are few, generally shallow and broad, and develop gradually.

Source: Florida Geological Survey Sinkhole Map and Database updated 2008.

Explanation	
•	Documented sinkhole occurrence (Note 1)
Sinkhole Type, Development, and Distribution in Florida Map (Note 2)	
	Area I. Bare or thinly covered limestone. Sinkholes are few, generally shallow and broad, and develop gradually. Solution sinkholes dominate.
	Area II. Cover is 30 to 200 feet thick. Consists mainly of incohesive and permeable sand. Sinkholes are few, shallow, of small diameter, and develop gradually. Cover-subsidence sinkholes dominate.
	Area III. Cover is 30 to 200 feet thick. Consists mainly of cohesive clayey sediments of low permeability. Sinkholes are most numerous, of varying size, and develop abruptly. Cover-collapse sinkholes dominate.
	Area IV. Cover is more than 200 feet thick. Consists of cohesive sediments interlayered with discontinuous carbonate beds. Sinkholes are very few, but several large diameter, deep sinkholes occur. Cover-collapse sinkholes dominate.



Site Specific Dissolution Issues

- **The Florida Geological Survey (FGS/USGS) map & report (1985)**
 - Limestones underlying southeastern Florida have few sinkholes
 - Limestones exhibit shallow surface depressions
 - Dissolution develops gradually, not catastrophically
- **The FGS “Sinkhole Website” does not list any occurrence of sinkholes in Dade County through February 2008**
- **The FSAR & SER for Turkey Point Units 3 & 4, and an engineering report (1976) on the Units 3 & 4 foundation:**
 - The underlying limestones do not present a danger to foundations
 - Technical basis: good core recovery, examination of core samples and rock exposures in excavations, absence of karst topographic features, diver reconnaissance of deep excavations

Dissolution Investigation

- **Field reconnaissance identified shallow surface depressions**
- **Borings did not find any significant dissolution features**
 - Good core recovery: 60 to 80 percent
 - Negligible rod drops occurred during drilling
 - No unusual loss of drilling fluid
 - Caliper logs did not indicate any large voids
 - Acoustic logs did not indicate any large voids
- **Geophysical investigation is planned to confirm the absence of dissolution cavities. Planned completion by Spring 2009.**

References

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