Phosphorus Release from the Biscayne Aquifer with Sea Level Rise

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WHERE DISCOVERIES BEGIN

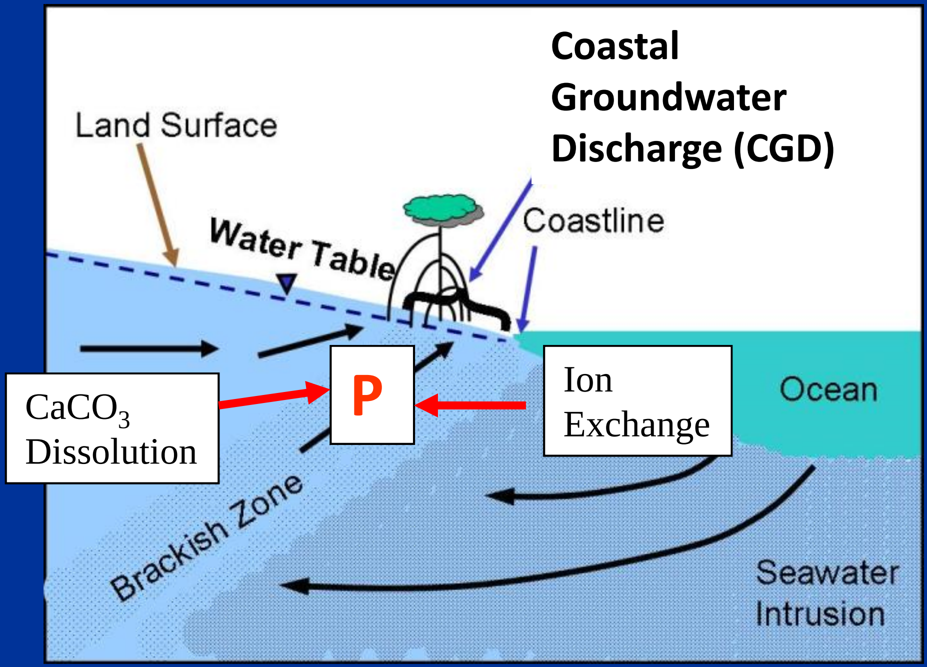
As Seawater intrudes into a coastal carbonate aquifer:

P is released due to:

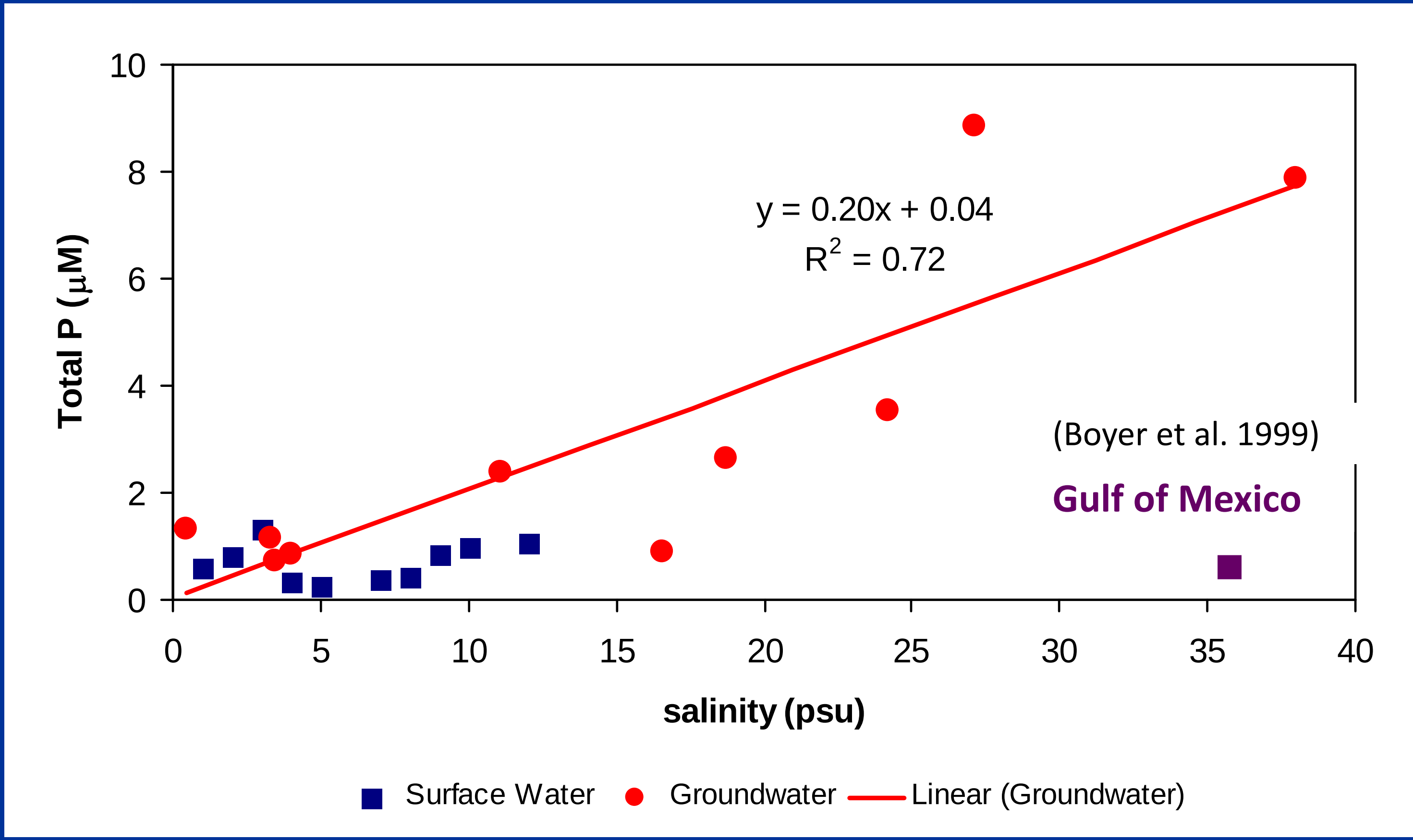
$CaCO_3$ dissolution at salinities < 30 psu

Ion exchange with HCO_3^- at salinities 30-33 psu

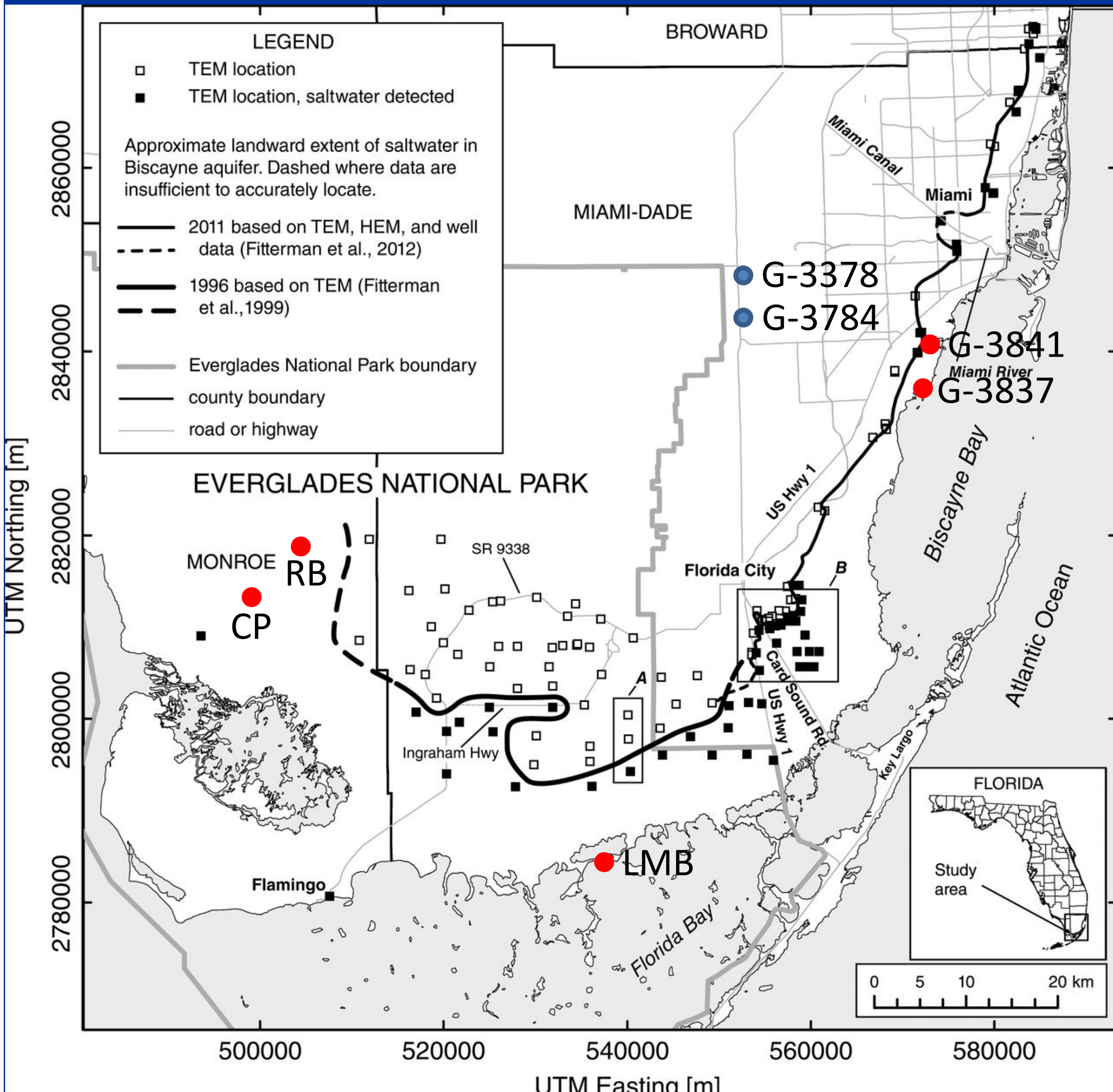
At salinities >33 psu P was retained due to $CaCO_3$ precipitation



Price, et al., 2010, *Applied Geochemistry,* 25:1085–1091.



Price, et al., 2006, Hydrobiologia, 569:23-36.



Fitterman, J Environ Eng Geophysic, 2014, 19(1): 33-43.

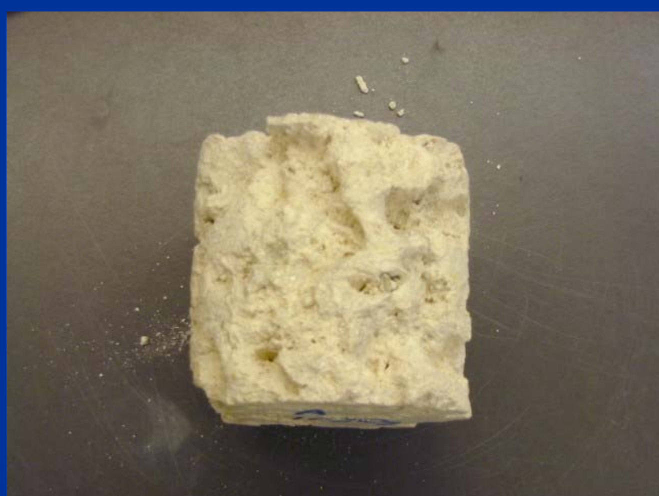
How much P is incorporated in the Biscayne Aquifer, and in what form?

Selected 7 cores from the USGS

2 in freshwater portion
4 in seawater intrusion of the Biscayne Aquifer

METHODS

Rock core was collected every ~1.5 m (5 ft)
Then sub-sampled into 6 pieces each 0.5 g.



METHODS Cont.

The amount of P was determined using a sequential extraction procedure developed by Ruttenberg (1992).

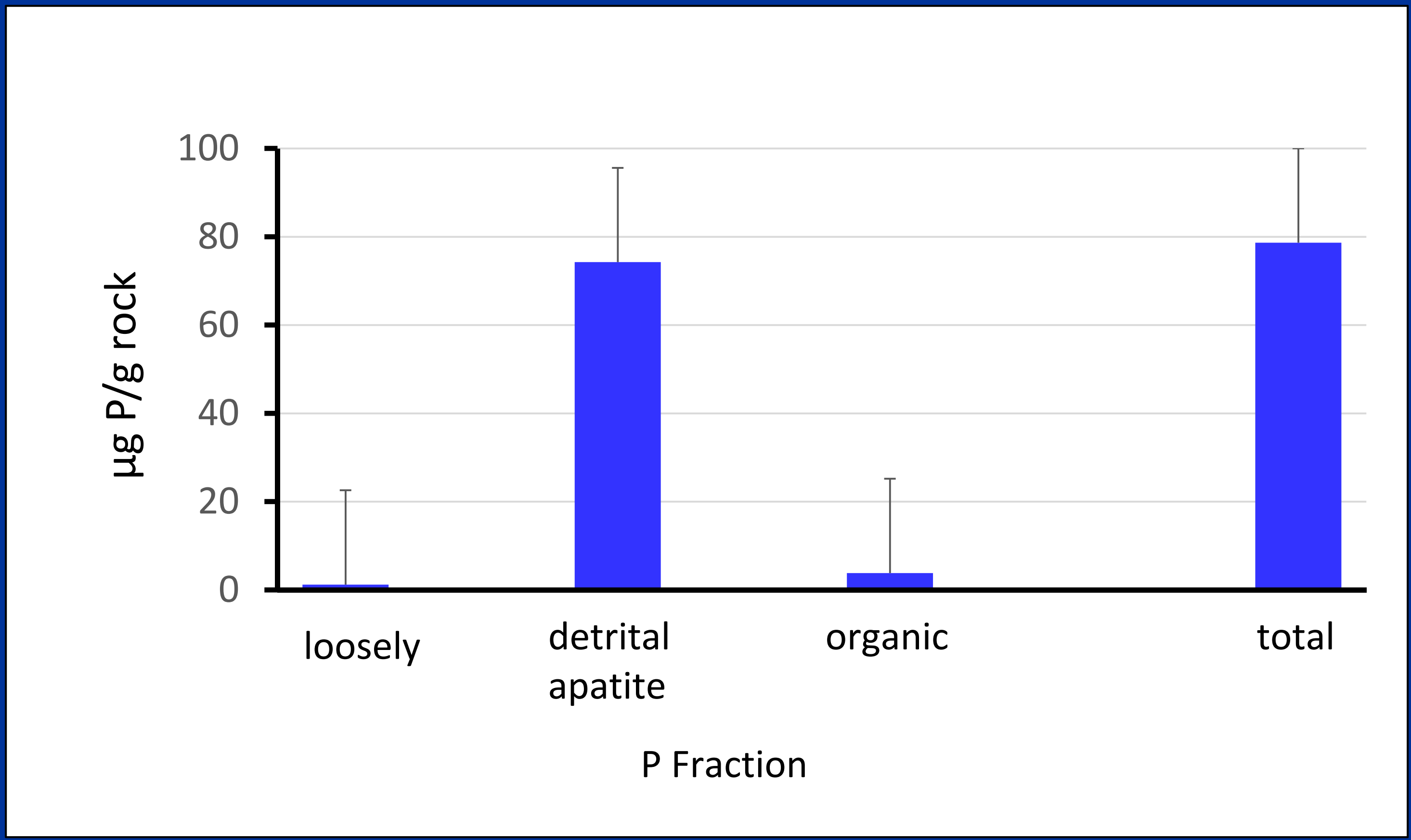
1. Loosely adsorbed P: MgCl Extract

2. Detrital apatite fractions of P: HCl Extract

3. Organic P: Filtering the HCl extract and ashing the filters in a muffle furnace

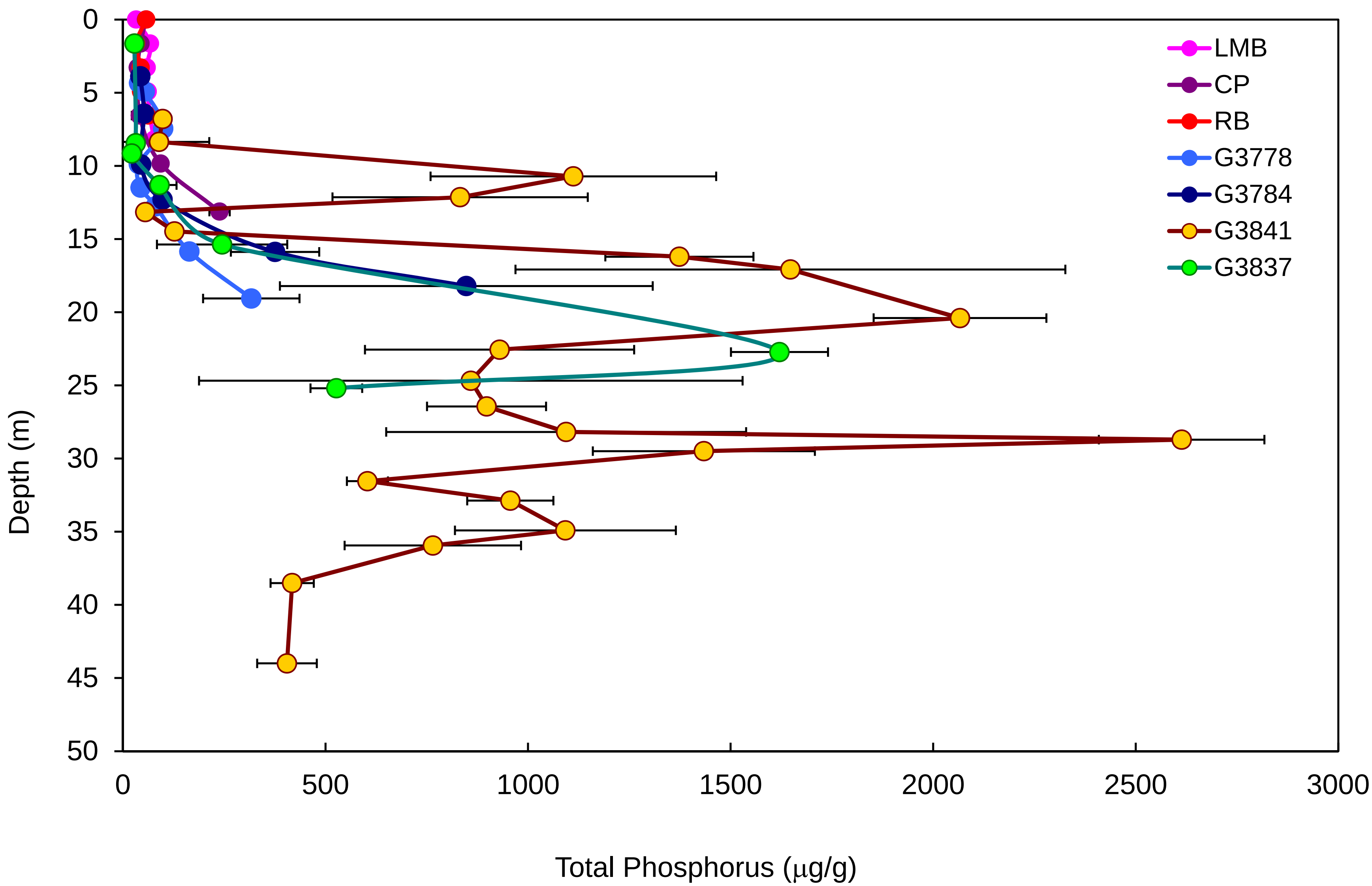
4. Total P: Sum of all the fractions

RESULTS



100
80
60
40
20
0
µg P/g rock
loosely
detrital apatite
organic
total
P Fraction

Total P with Depth



G-3837 **Water depth about 11 feet**

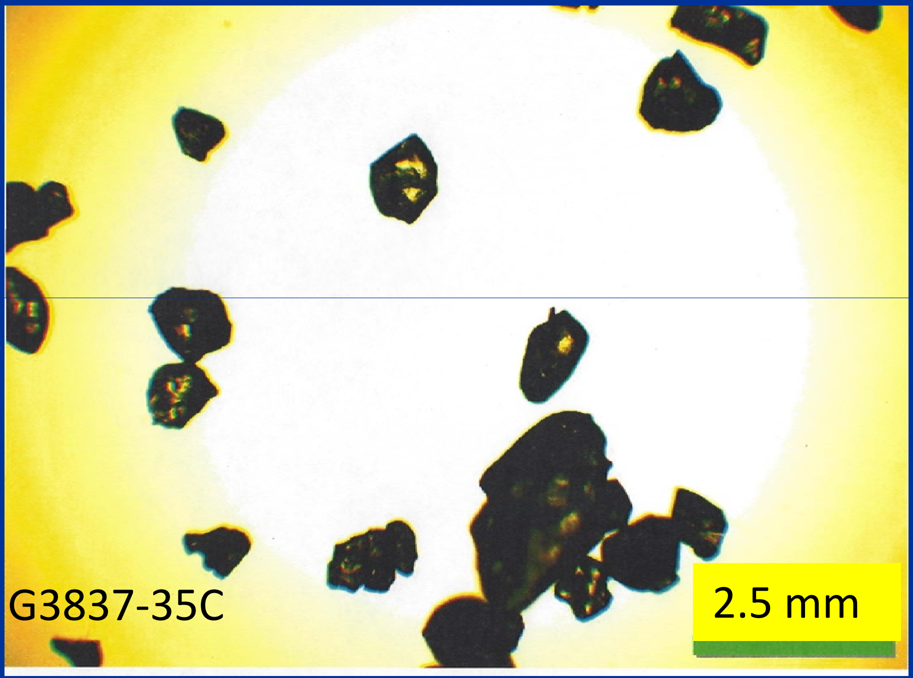
Depth (ft)	Depth (m)	Lithofacies
5.35	1.76	Burrow-mottled ooid grainstone, Ophiomorpha size decreases upward
17.13	5.62	Burrow-mottled ooid grainstone, Ophiomorpha size decreases upward
25.75	8.45	SCHIZPORELLA-pelecypod rudstone w/burrowed, ooid grainstone matrix
27.90	9.15	Pedogenic limestone soil breccia
34.46	11.31	Burrowed wackestone **w/sand** filled burrows
38.84	12.74	Burrowed skeletal wackestone and grain/mud dominated packstone
41.68	13.67	Burrow mottled **sandy** mudstone/wackestone and skeletal quartz sandstone
46.85	15.37	Skeletal quartz **sandstone**
51.67	16.95	**Sandy** skeletalgrain dominated packstone/grainstone
59.10	19.39	**Sandy** pelecypod floatstone
65.50	21.49	**Sandy** skeletal, benthic FORAM grainstone and skeletal sandstone
69.25	22.72	Burrow mottled **sandy** grainstone and skeletal wackestone
76.80	25.20	**Sandy** mud/grain dominated skeletal packstone
80.45	26.39	Pelecypod, bryozoan, red alge, echinoid floatstone **w/sandy** skeletal grainstone/packstone matrix
87.50	28.71	Pelecypod floatstone **w/sandy** skeletal, benthic FORAM, red algal grainstone/packstone matrix
90.25	29.61	**Sandy** skeletal grainstone and grain dominated packstone
94.30	30.94	**Sandy** pelecypod grainstone and mud/grain-dominated packstone matrix
97.90	32.12	**Sandy** pelecypod fragment grainstone and mud/grain dominated packstone matrix
102.30	33.56	**Sandy** pelecypod fragment grainstone and grain-dominated packstone
105.80	34.71	**Sandy** pelecypod fragment grainstone and grain-dominated packstone
109.50	35.93	Pelecypod and intraclast floatstone **w/sandy** grainstone and mud/grain-dominated packstone matrix

Descriptions by K. Cunningham From USGS

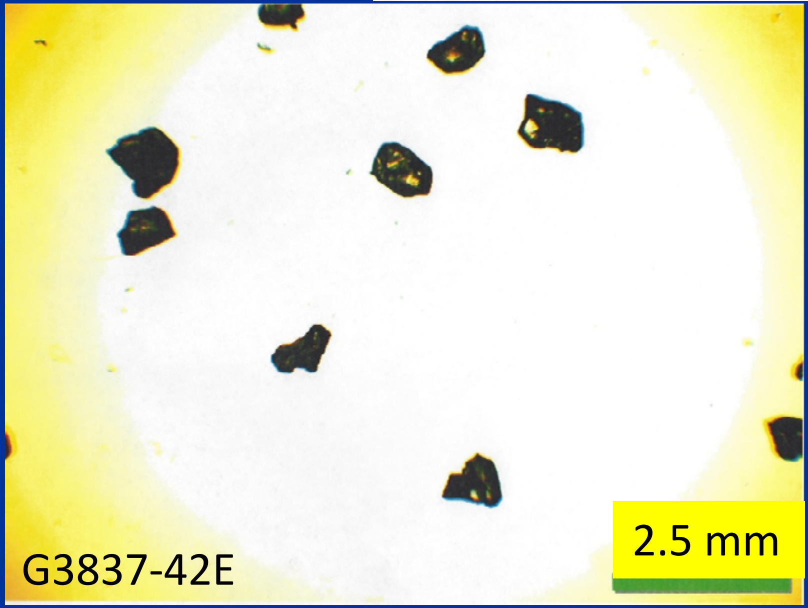
Core G-3841		Water depth about 11 feet
Depth		Lithofacies
5.24	1.72	Cross-laminated and cross-bedded ooid grainstone
11.25	3.69	Cross-laminated and cross-bedded ooid grainstone
18.00	5.91	Cross-laminated and cross-bedded ooid grainstone
20.71	6.79	Monastrea framestone
25.47	8.36	Coral framestone
32.66	10.72	Burrow-mottled sandy skeletal grainstone to grain-/mud-dominated packstone and skeletal sandstone
37.00	12.14	Burrow-mottled sandy skeletal grainstone to grain-/mud-dominated packstone and skeletal sandstone
40.09	13.15	Pelecypod, benthic foram grain-/mud-dominated packstone/wackestone
44.13	14.48	Porites coral bafflestone w/benthic foram wackestone matrix
49.40	16.21	Sandy skeletal, benthic foram, pelecypod sandstone
57.05	18.72	Pelecypod, rhodolith floatstone w/skeletal sandstone matrix
62.18	20.40	Sandy pelecypod, benthic foram, skeletal grain-/mud-dominated packstone
68.75	22.56	Red algal, skeletal and skeletal grainstone
75.23	24.68	Rhodolith floatstone/rudstone w/skeletal grain to grain-dominated packstone matrix
80.58	26.44	Pelecypod floatstone w/sandy skeletal grainstone matrix
85.90	28.18	Pelecypod floatstone w/sandy skeletal grainstone matrix
89.90	29.49	Sandy skeletal fragment grain-dominated packstone
96.63	31.70	Sandy pelecypod, benthic foram, skeletal grain-/mud-dominated packstone
102.21	33.53	Red algal, skeletal and skeletal grainstone
107.80	35.37	Rhodolith floatstone/rudstone w/skeletal grain to grain-dominated packstone matrix
113.38	37.20	Pelecypod floatstone w/sandy skeletal grainstone matrix
118.96	39.03	Pelecypod floatstone w/sandy skeletal grainstone matrix
124.34	40.79	Poorly consolidated skeletal quartz sandstone and sandy pelecypod fragment grain-dominated packstone
134.10	44.00	Sandy pelecypod fragment grain-dominated packstone

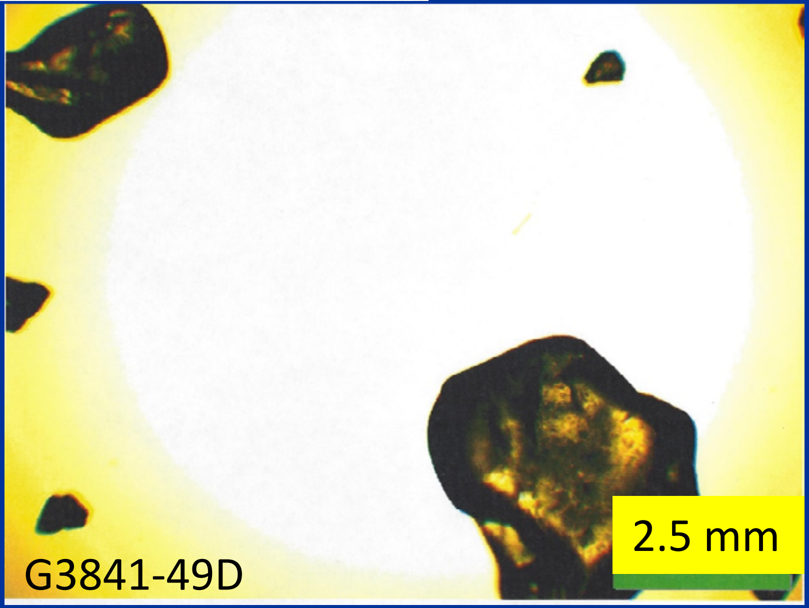
Core Descriptions by K. Cunningham From USGS

Plain Polarized Light of thin sections



Phosphorite Grains





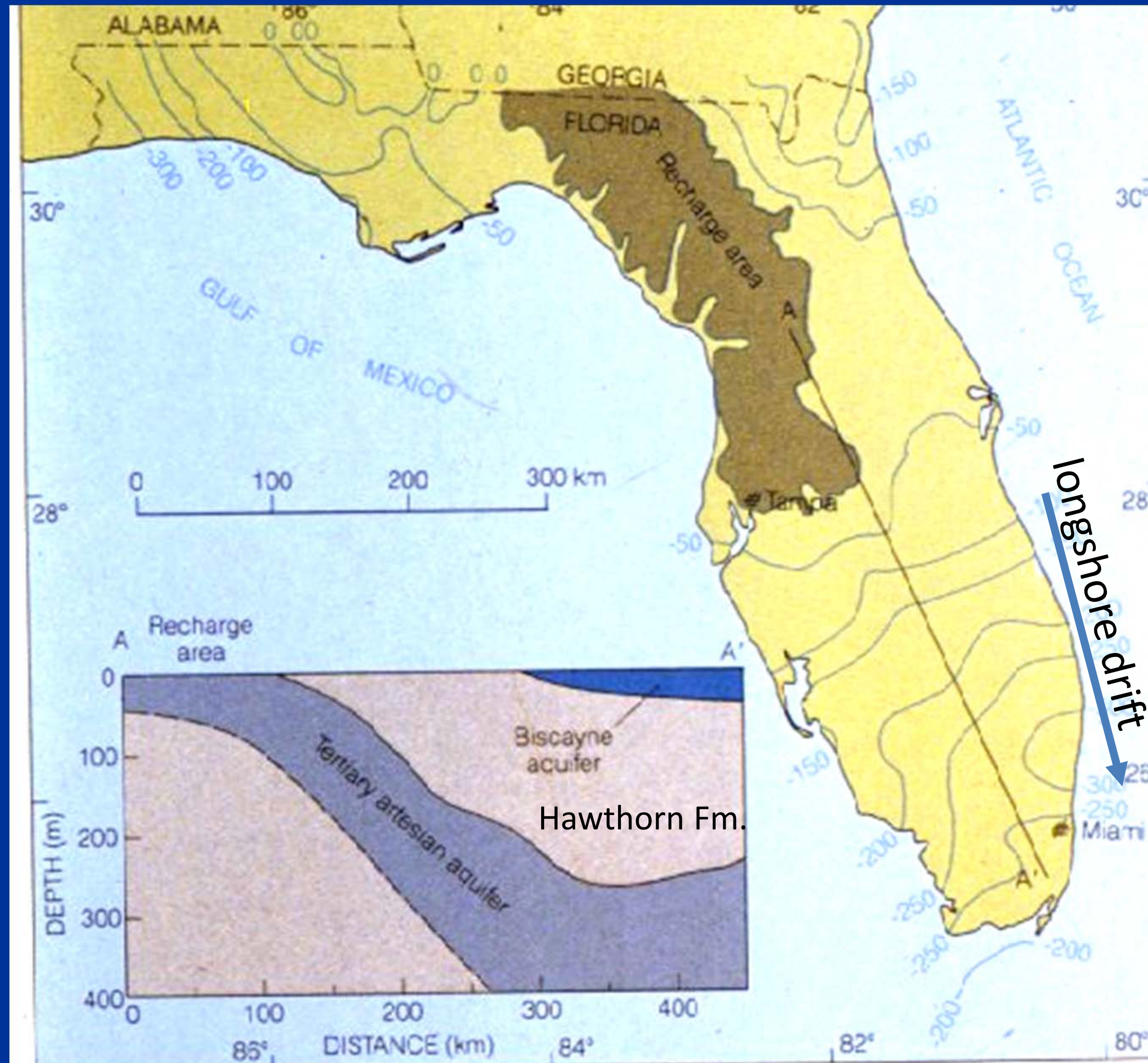
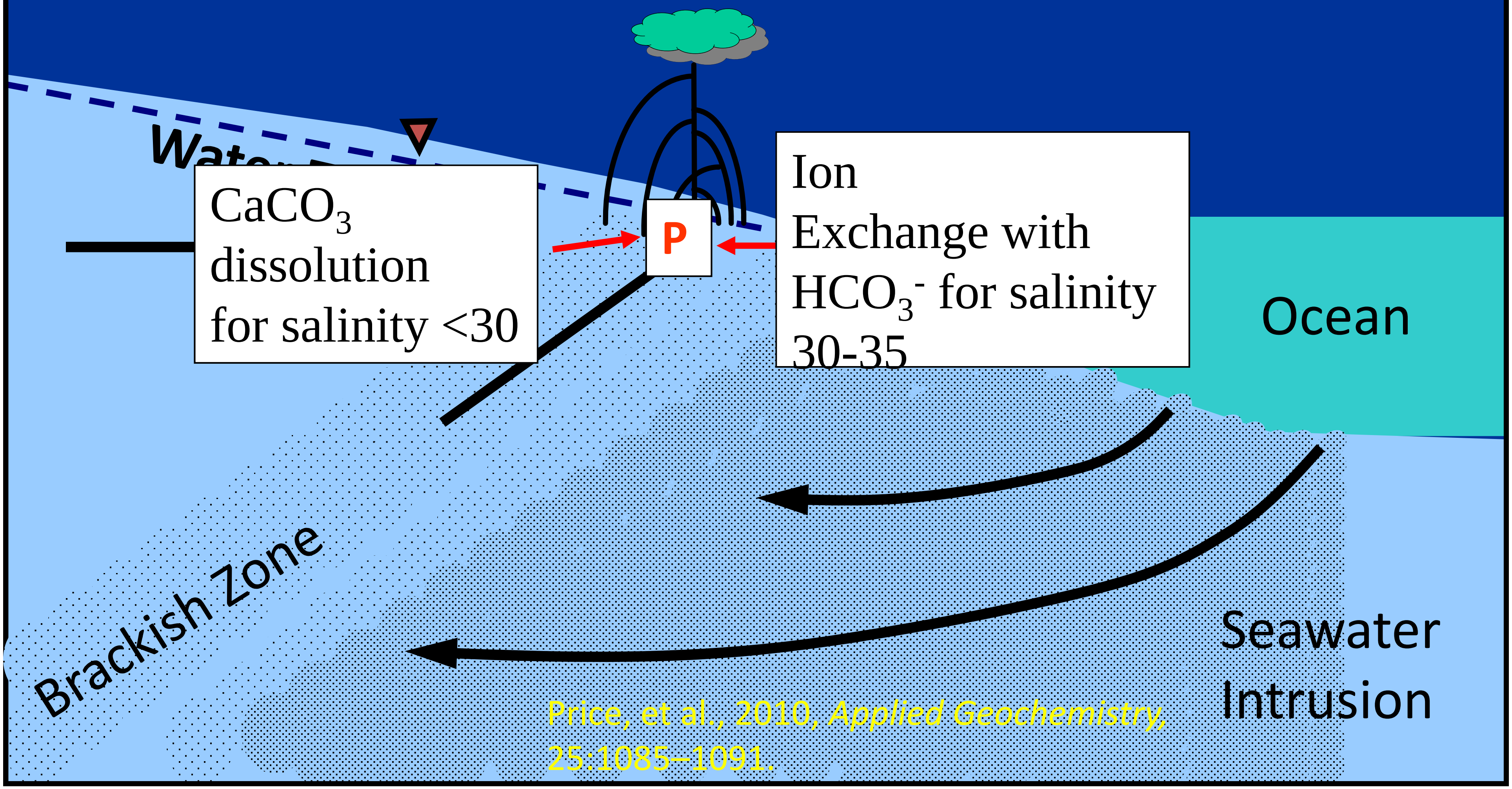


FIGURE 9.12 Map of the Florida peninsula showing depth to top of the Tertiary limestone artesian aquifer (in meters) and the area of recharge. Inset diagram shows a stratigraphic section along line A–A'. In the southern part of the state, the Tertiary aquifer lies below a surface aquifer in younger rocks. (*Source:* After Cederstrom et al., 1979.)

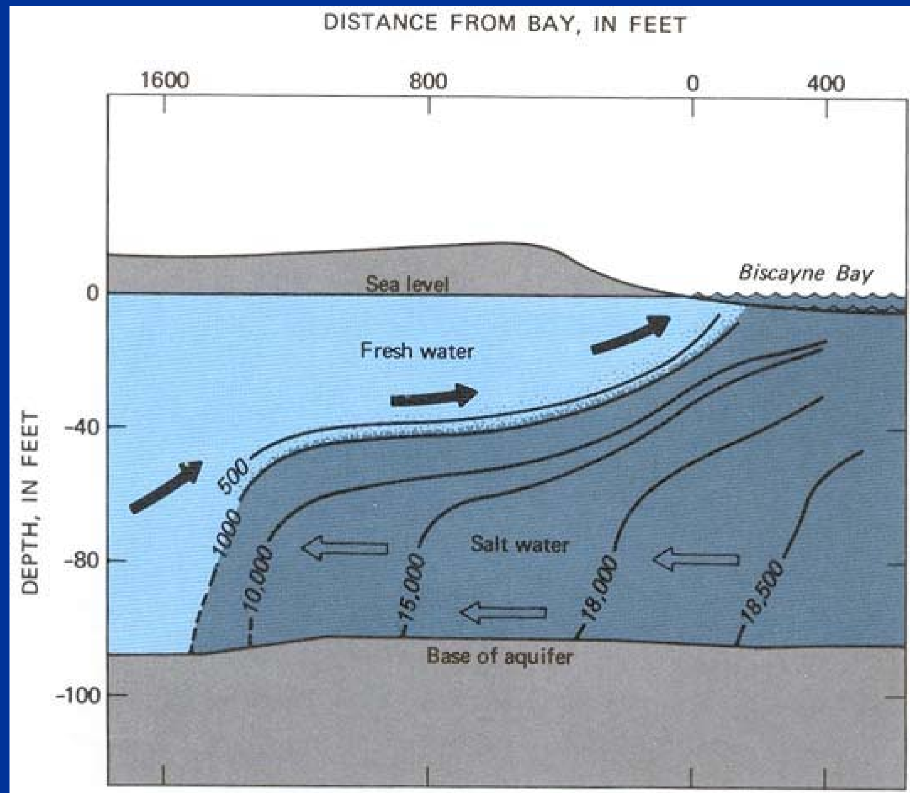
Conclusions

- P concentrations in the upper 10 m of the Biscayne Aquifer average about 50 µg P/g of rock.
- Below 10 m P concentrations in the Biscayne Aquifer ranged from 100 to 2500 µg P/g of rock.
- The high concentrations of P below 10 m in the Biscayne Aquifer is in the form of sand-sized grains of detrital apatite.

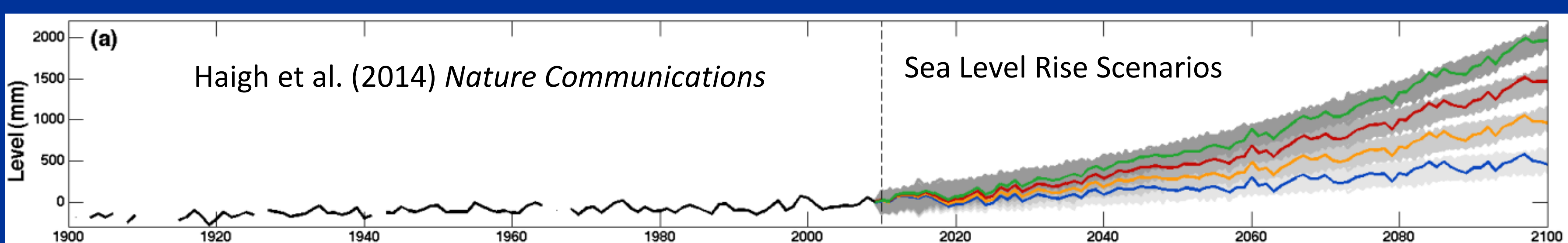
Processes releasing P from shallow portion (<3 m) of the Biscayne Aquifer are known.



Additional Work



Credit: United States Geological Service, http://sofia.usgs.gov/publications/reports/rali/images/41diagramx.jpg



Acknowledgements

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FCE LTER

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Long Term Ecological Research