EPSCOR Merging the Data Needs of the State Agencies with those of the Scientific Community

A Proposal for a Collaborative Resource (Re-)Analysis

Don Thomas, Erin Wallin, Nicole Lautze, Eric Haskins, Robert Whittier, & The EPSCOR Team

(To State the Obvious)

- The quality of Hawai'i's ground-water resources are among the best in the world
- We all recognize these resources as critical assets for our communities
- For most communities, the available resource is adequate to meet current needs.... BUT

The resource is under varying degrees and urgencies of threat from multiple stressors:

- Increasing demand on a finite resource
- Contamination
  - Red Hill (headlines)
  - Pesticide use – (headlines)
  - Wastewater Disposal
    - Injection (headlines)
    - On-Site Disposal (headlines)
    - Reuse
- Climate Change
  - Manmade - or Not – headlines (cause doesn't matter, it happens)

- These threats are managed by
  - **CWRM – to protect groundwater from over production**
  - **DOH – to protect groundwater from contamination**
  - **DWS - to ensure quality groundwater is delivered to the user**

All over committed and under-resourced to fully manage the complete spectrum of threats that the resource is subject to…

To Address These threats Requires:

- **An understanding of the groundwater issues facing Hawaii**
- **A scientific understanding of the groundwater flow and contaminant transport processes**
- **An Academic/Agency collaboration**

The Hawaii Island Water Example Problem

Science Problem:

We don’t yet fully understand the evolution of Hawai’i’s volcanoes

Agency Problem

No on-site water source for the Pohakuloa Training Area

The Hawaii Island Water Problem

- Seemingly unrelated but merged to a common path!

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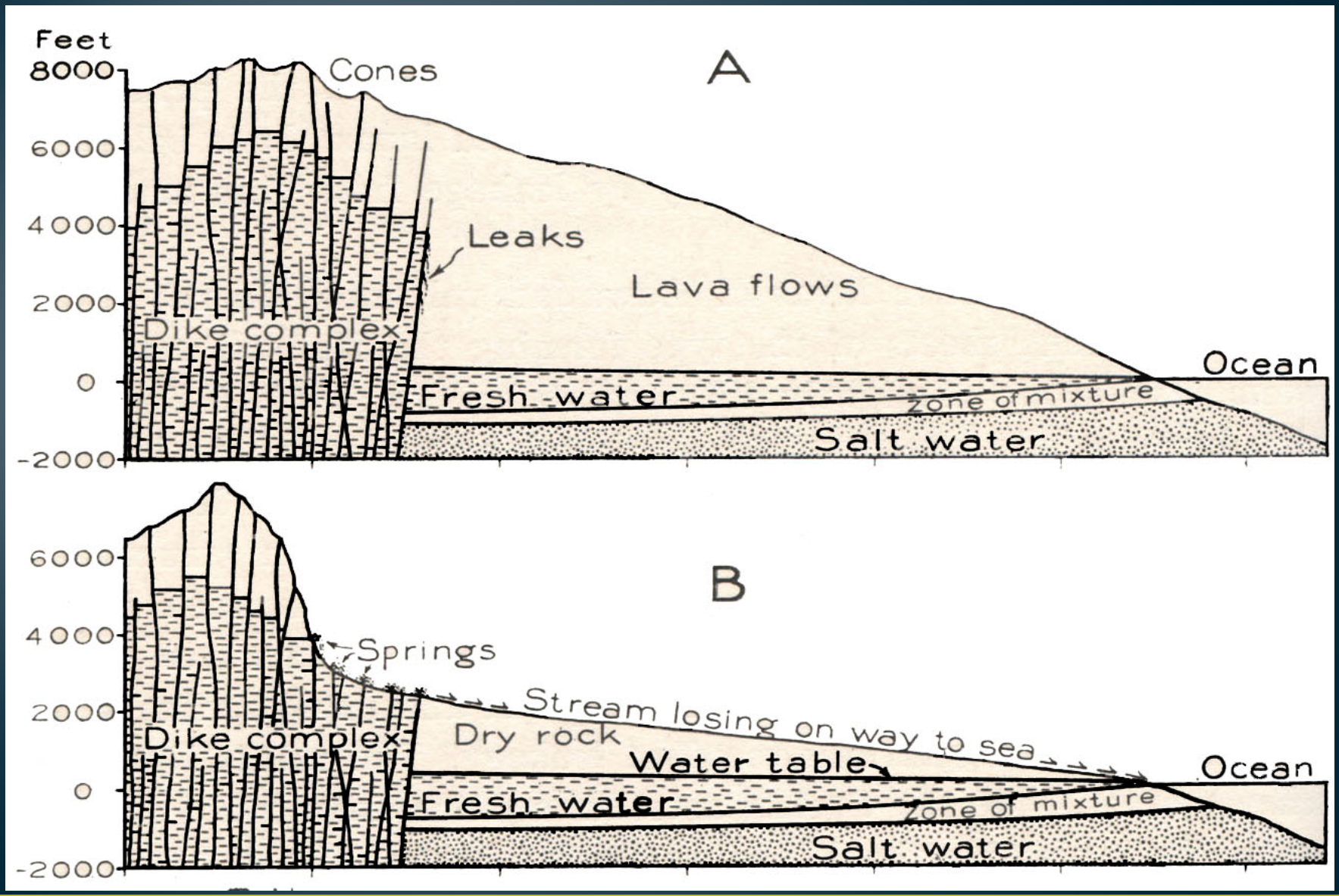
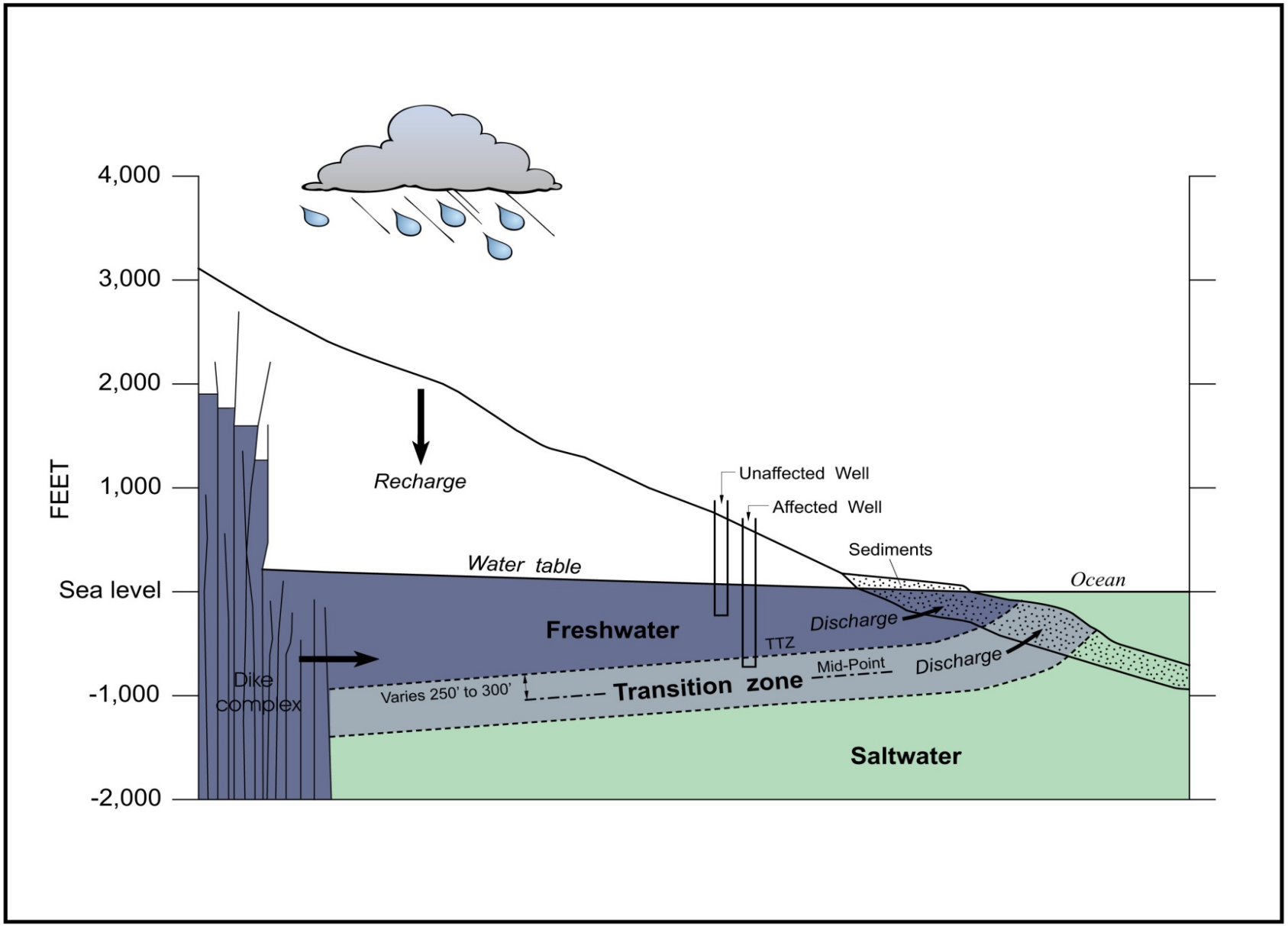
- The path is a re-assessment of how we view groundwater storage and flow
- First is a re-evaluating our conceptual model of groundwater flow

Conceptual Model for Hawaii's Groundwater



Conceptual Model for Hawaii's Groundwater

Hasn't changed much in over 70 years


4,000
3,000
2,000
1,000
Sea level
-1,000
-2,000
FEET
Recharge
Unaffected Well
Affected Well
Sediments
Water table
Ocean
Freshwater
Discharge
TTZ
Mid-Point
Discharge
Dike complex
Varies 250' to 300'
Transition zone
Saltwater

If Our Conceptual Models Are Inaccurate:

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- Why do we care?

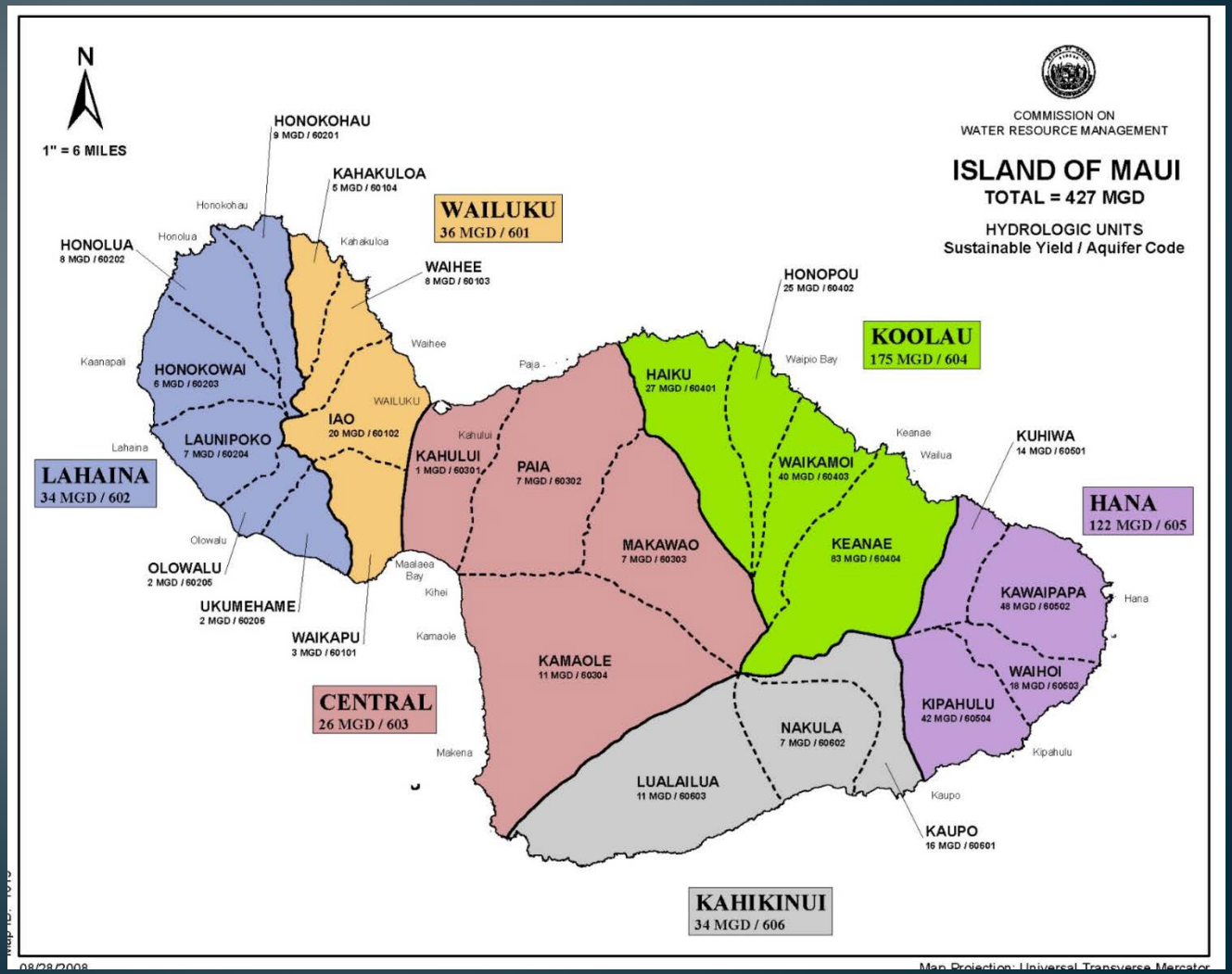
If Our Conceptual Models Are Inaccurate:

- Why do we care?

- What is being done to reevaluate our knowledge of groundwater?

Why Do We Care?

Current management is based on surface features and the assumed discharge of groundwater at the coast

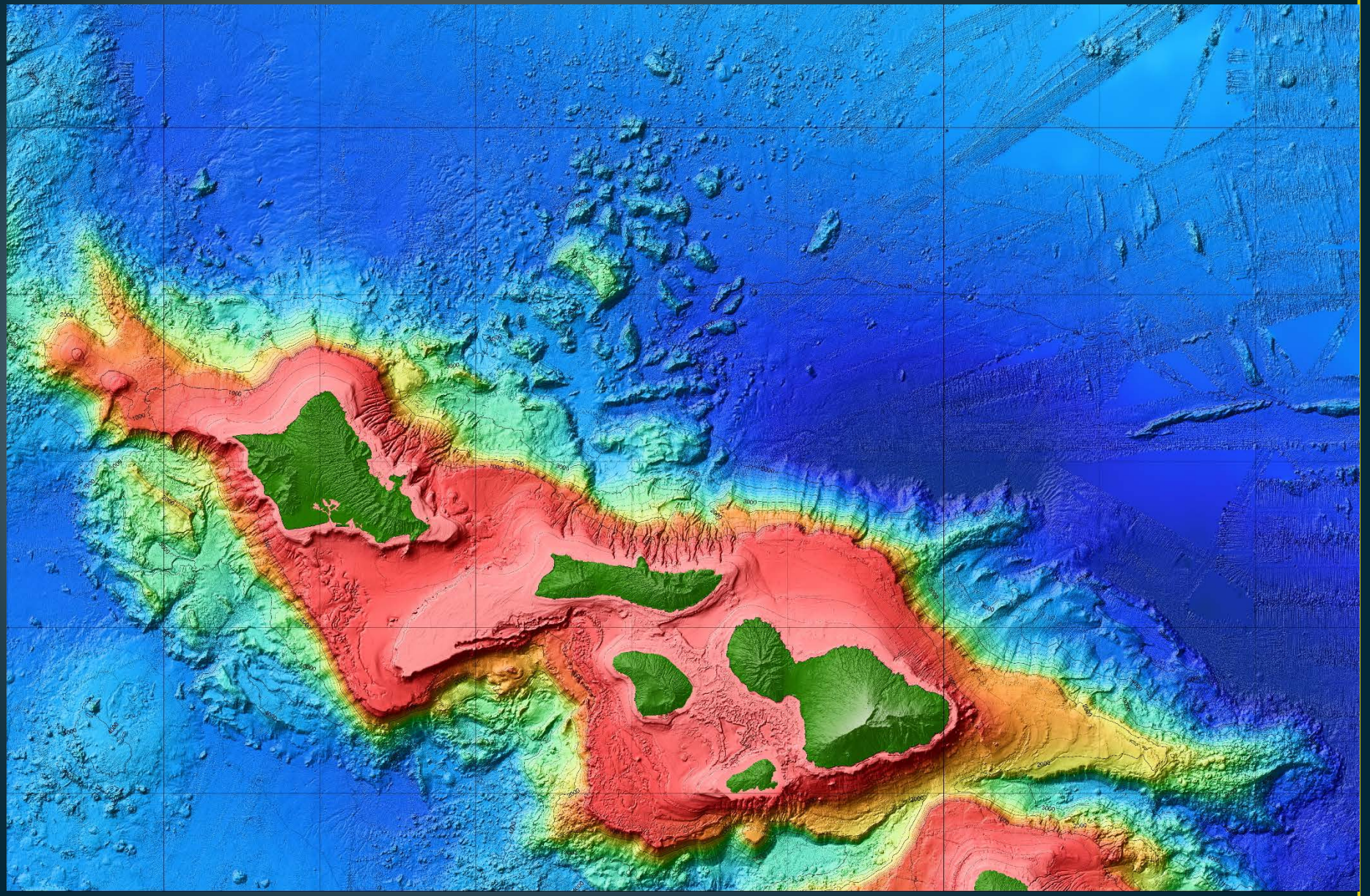


Why Do We Care?

Current management is based on surface features and the assumed discharge of groundwater at the coast

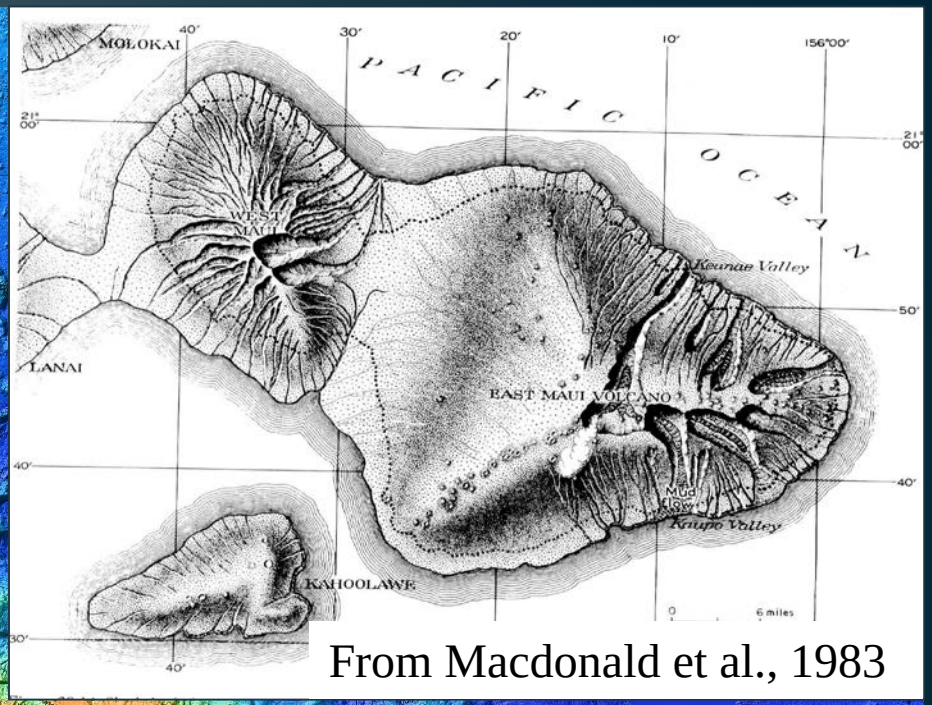
But what if groundwater storage and flow doesn't behave in this manner?

Maui Extends Well Beyond the Current Shoreline



Current Shoreline is a Relatively Recent Feature

Maui Shoreline During the Pleistocene, now largely submerged



From Macdonald et al., 1983

What is being done to reevaluate our knowledge of groundwater??

We are looking inside of the island

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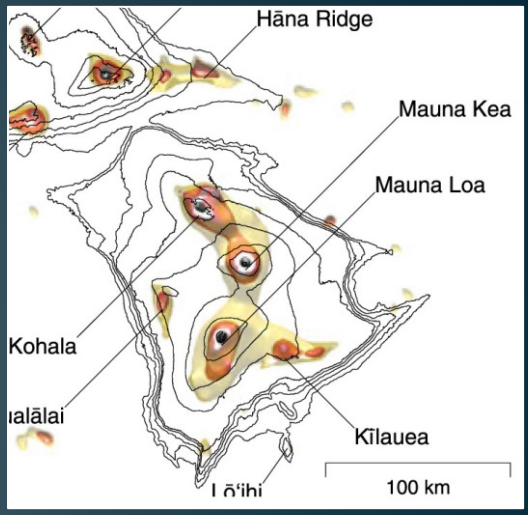

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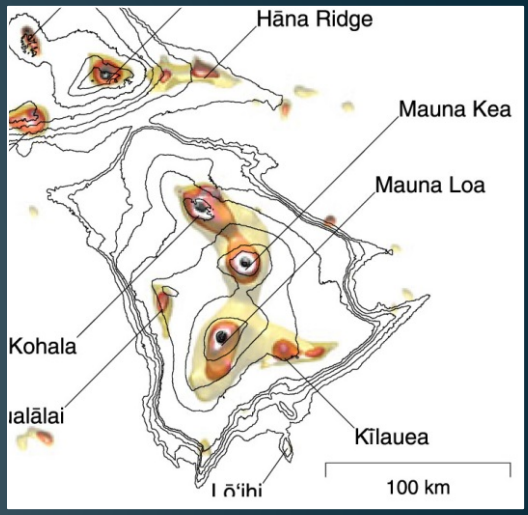

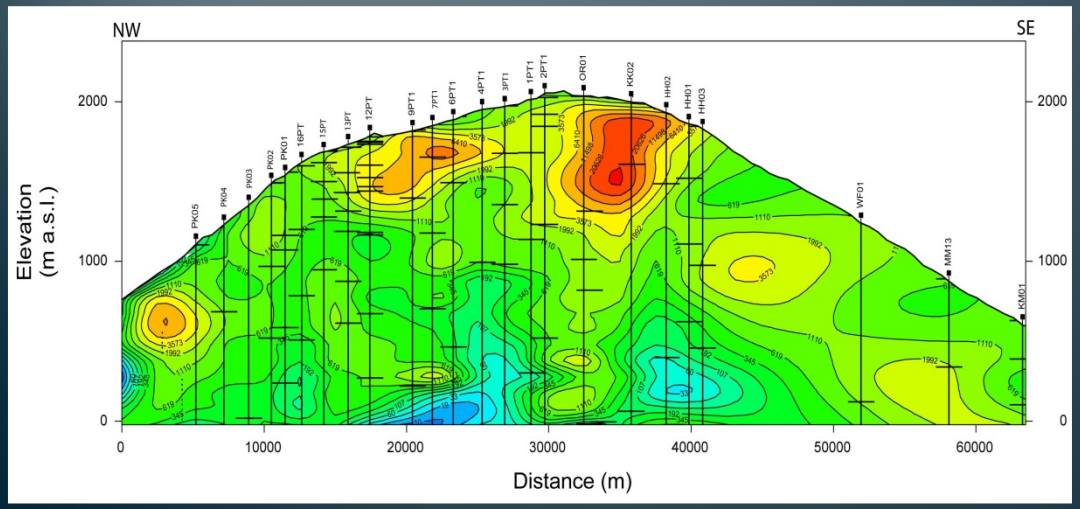

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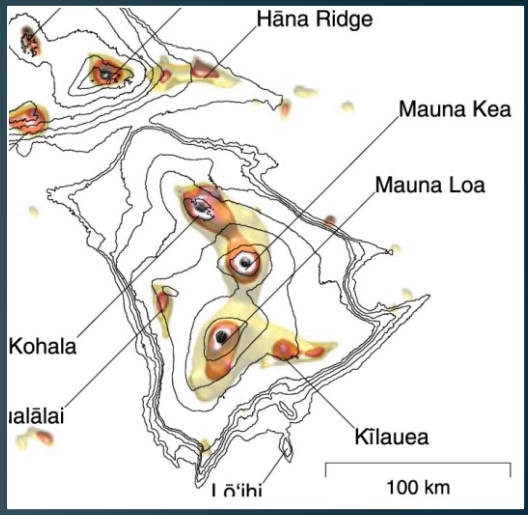
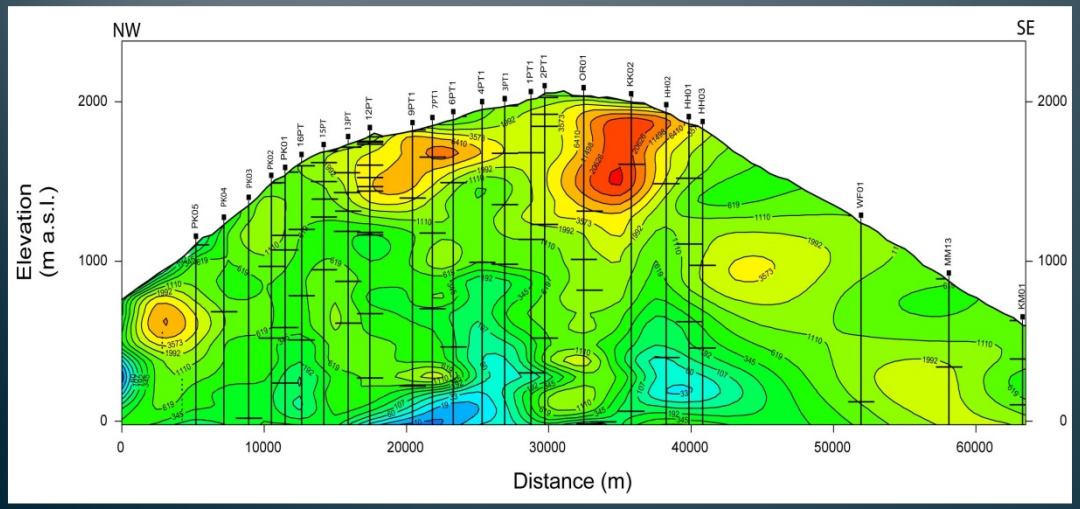




What Are We Finding?

Hawaii Scientific Drilling Project

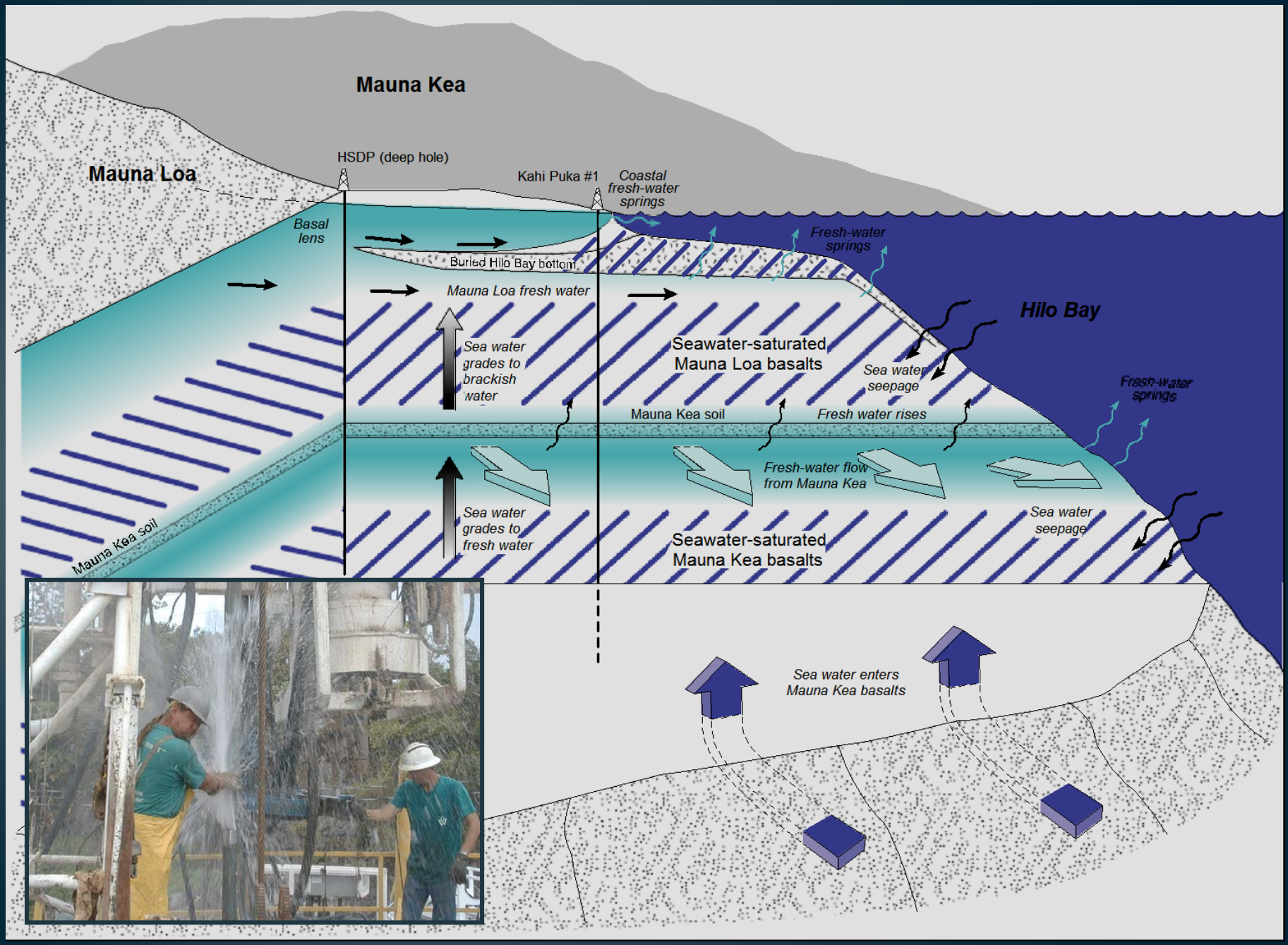
Primary motivation was geological not groundwater

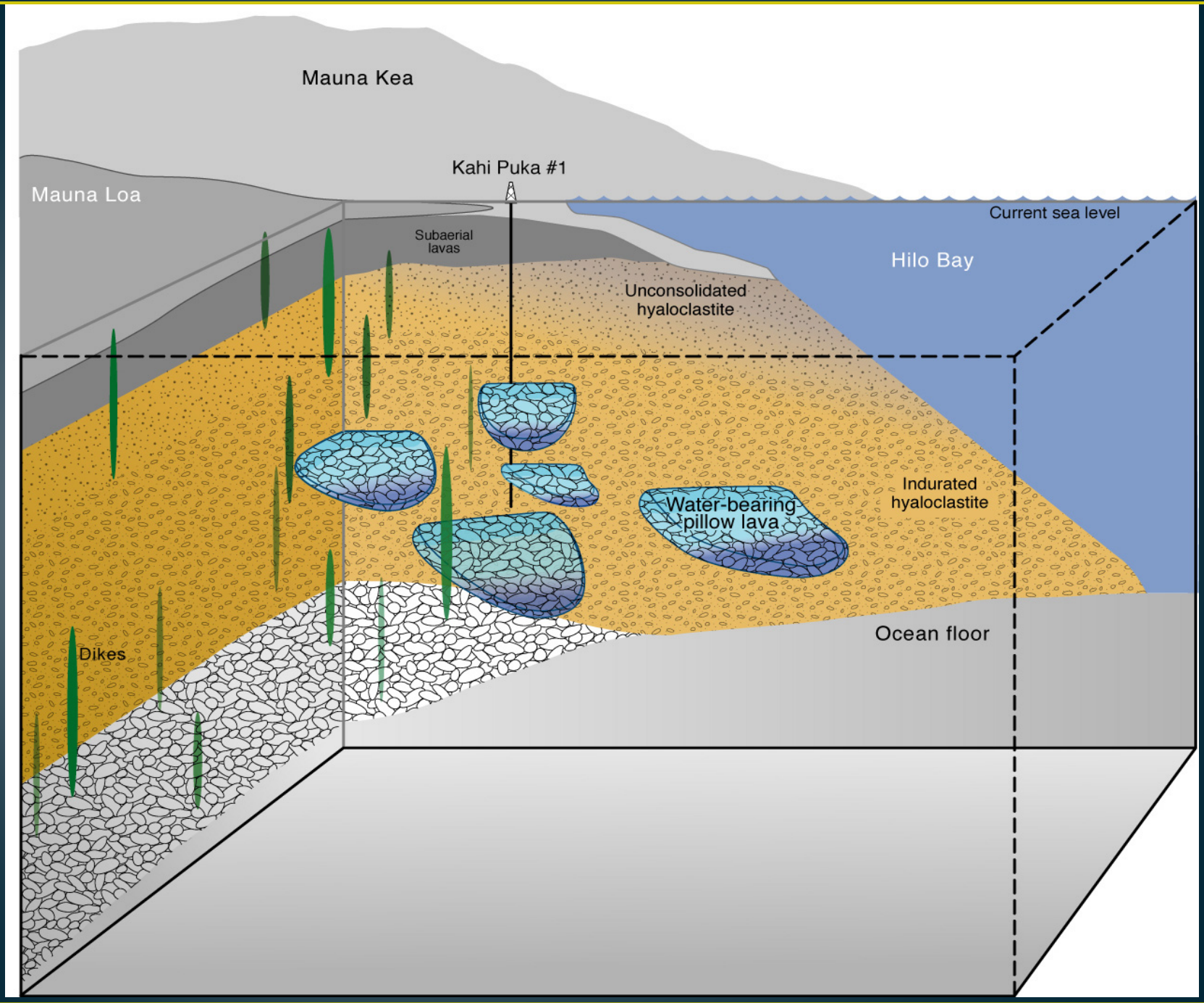
Fresh water where we didn't expect it!

- Artesian freshwater
- Encountered beneath saltwater
- Confined by the buried soils at the interface between Mauna Loa and Mauna Kea
- Also deeper layers of confined freshwater

- The hydrology of Mauna Kea is much more complicated than assumed:
  - Deep structures
  - Aquitards
  - Greater freshwater saturated volume

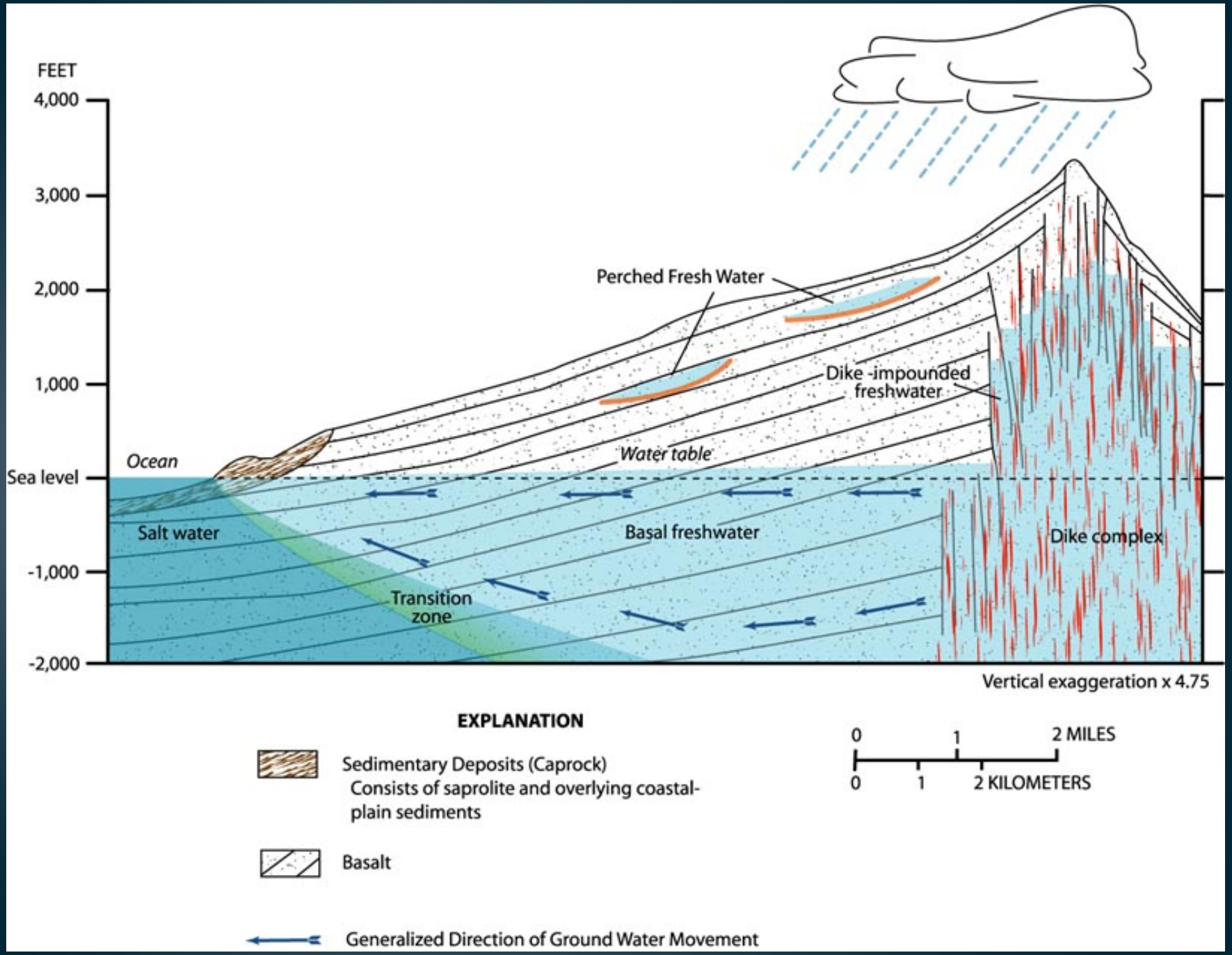
  Affecting the groundwater storage, accumulation, distribution, and flow

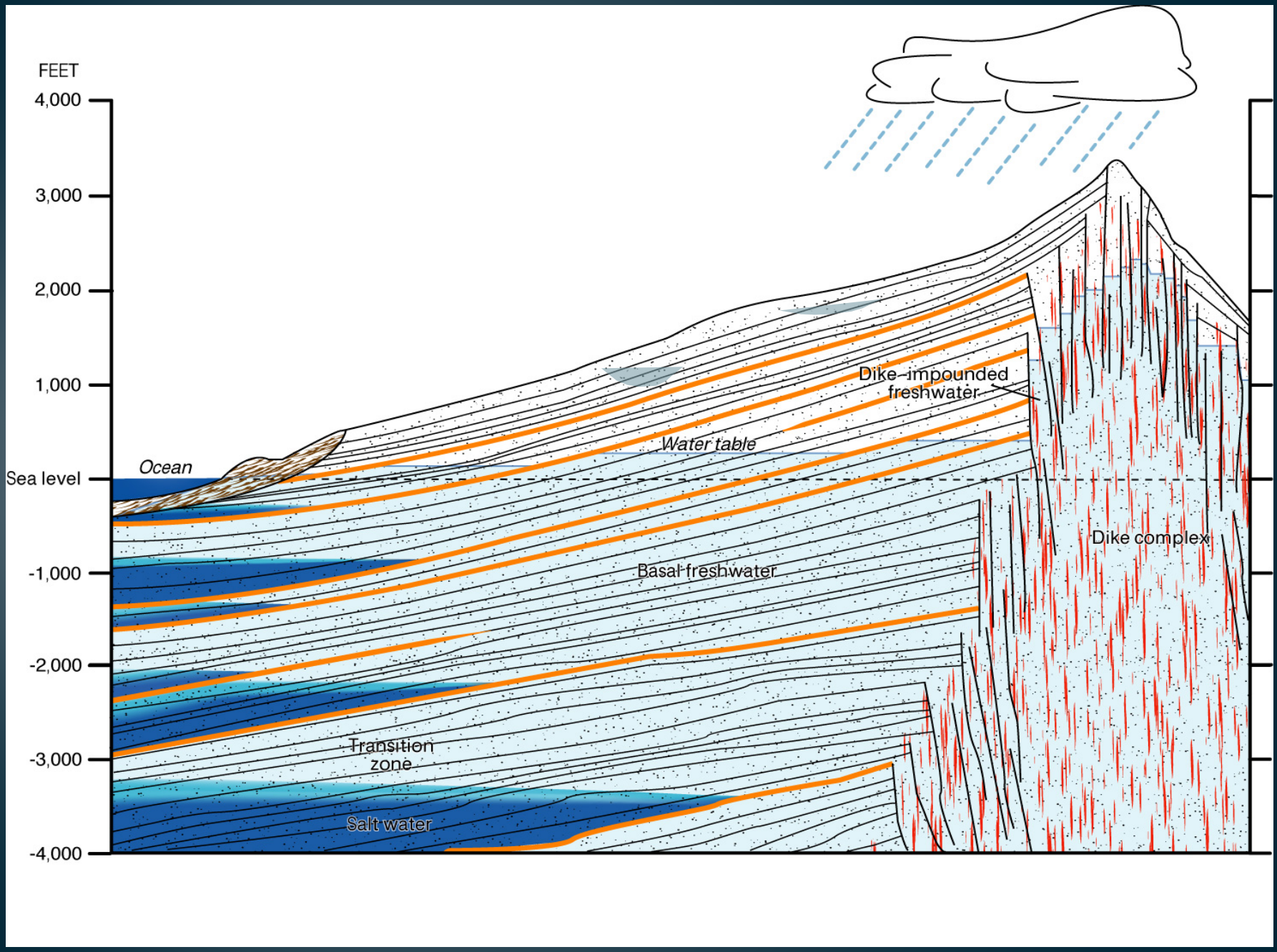

Mauna Kea
Mauna Loa
HSDP (deep hole)
Kahi Puka #1
Coastal fresh-water springs
Basal lens
Buried Hilo Bay bottom
Fresh-water springs
Mauna Loa fresh water
Hilo Bay
Sea water grades to brackish water
Seawater-saturated Mauna Loa basalts
Sea water seepage
Fresh-water springs
Mauna Kea soil
Fresh water rises
Fresh-water flow from Mauna Kea
Sea water grades to fresh water
Sea water seepage
Mauna Kea soil
Seawater-saturated Mauna Kea basalts
Sea water enters Mauna Kea basalts


Mauna Kea
Kahi Puka #1
Mauna Loa
Current sea level
Subaerial lavas
Hilo Bay
Unconsolidated hyaloclastite
Indurated hyaloclastite
Water-bearing pillow lava
Ocean floor
Dikes

The hydrology of Hawaii's volcanoes is complicated

- Hawaii's volcanoes are not large homogeneous "sponges" with uniform flow
- Deep structures, including dike complexes and aquitards are controlling groundwater accumulation, distribution, storage, and flow
- More water is being stored inside Mauna Kea than was thought
- To optimally manage and protect the aquifers we need to understand how these internal structures affect water (and contaminant) flow


FEET
4,000
3,000
2,000
1,000
Sea level
-1,000
-2,000
Perched Fresh Water
Dike -impounded freshwater
Water table
Ocean
Salt water
Basal freshwater
Dike complex
Transition zone
Vertical exaggeration x 4.75
EXPLANATION
Sedimentary Deposits (Caprock)
Consists of saprolite and overlying coastal-plain sediments
Basalt
Generalized Direction of Ground Water Movement
0
1
2 MILES
0
1
2 KILOMETERS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4,000
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Sea level
-1,000
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-3,000
-4,000
Ocean
Water table
Dike–impounded freshwater
Dike complex
Basal freshwater
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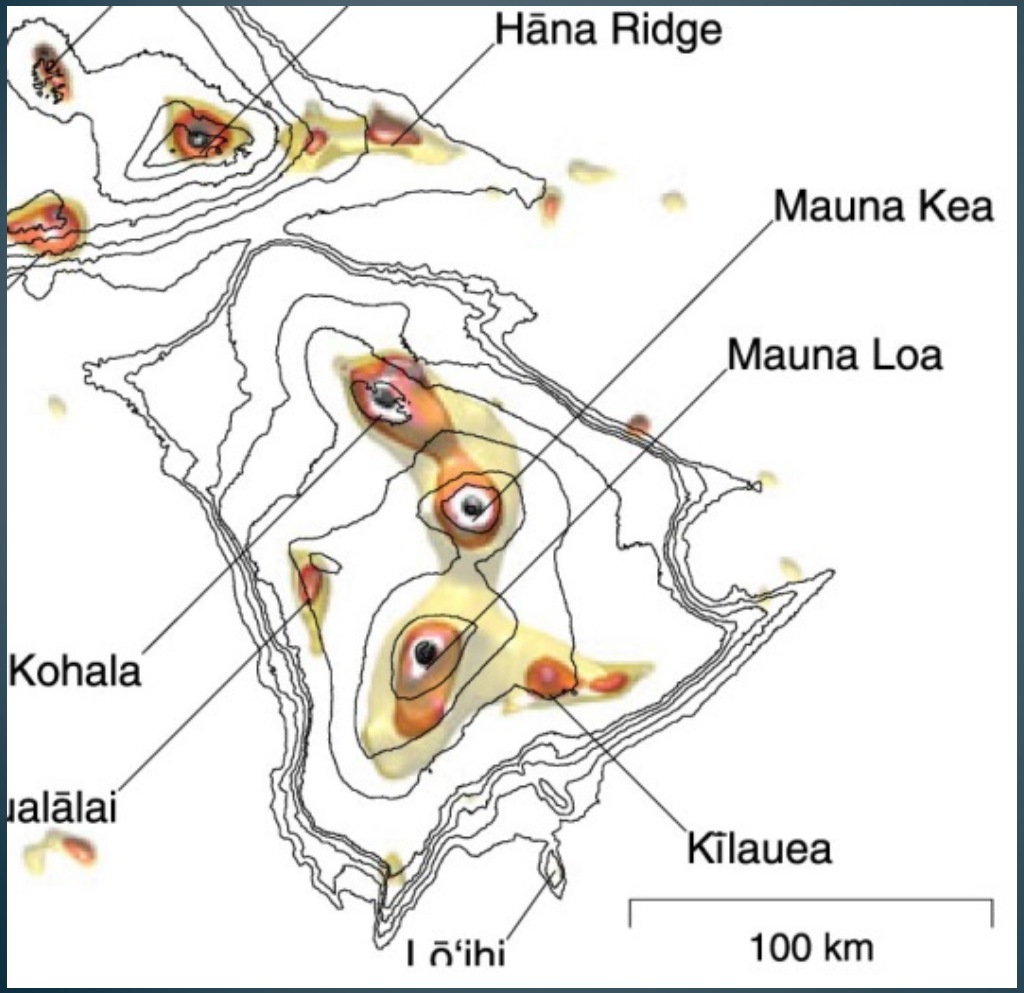
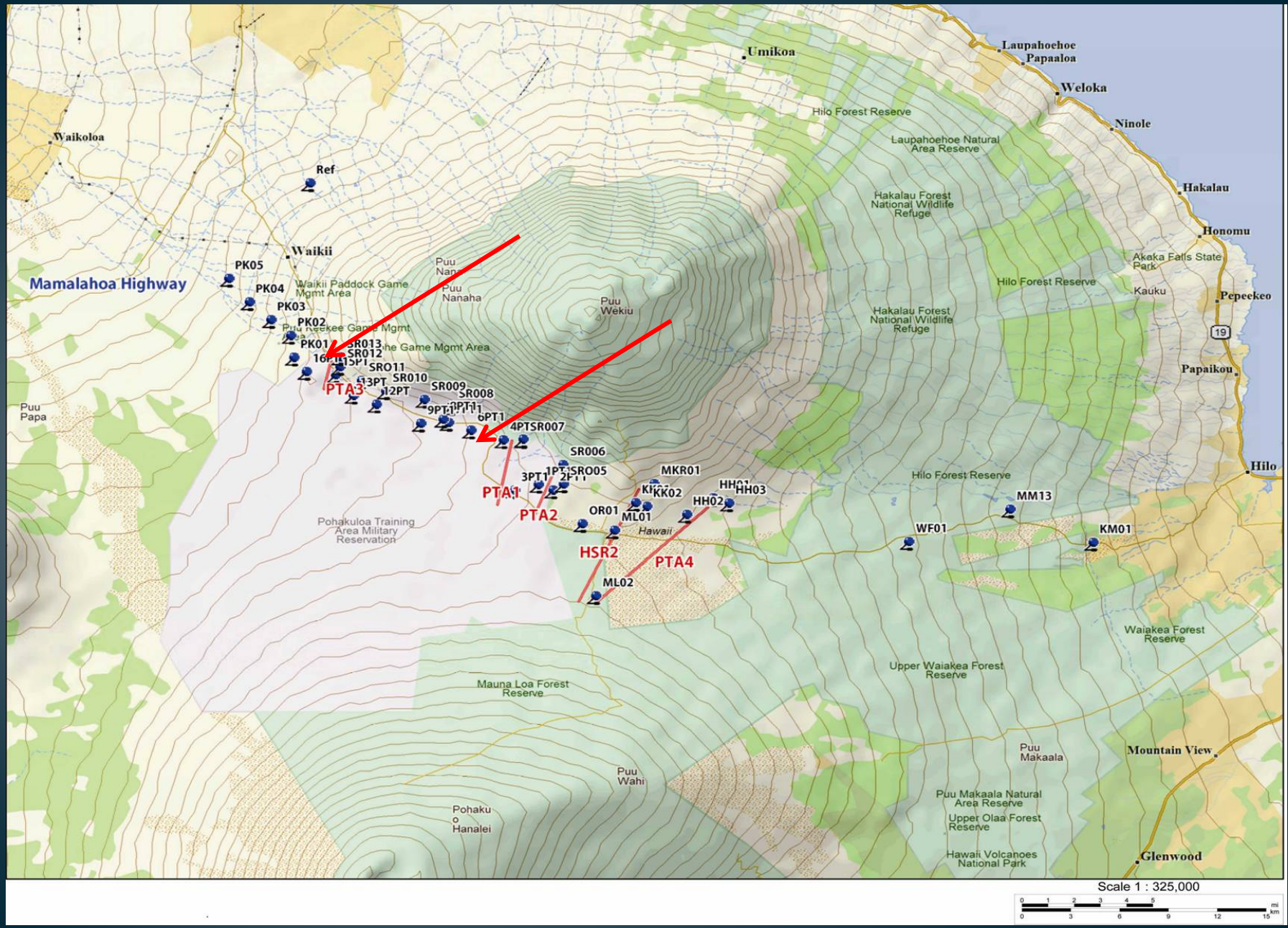
Salt water

What Are We Finding?

Gravity survey (Flinders, 2013)



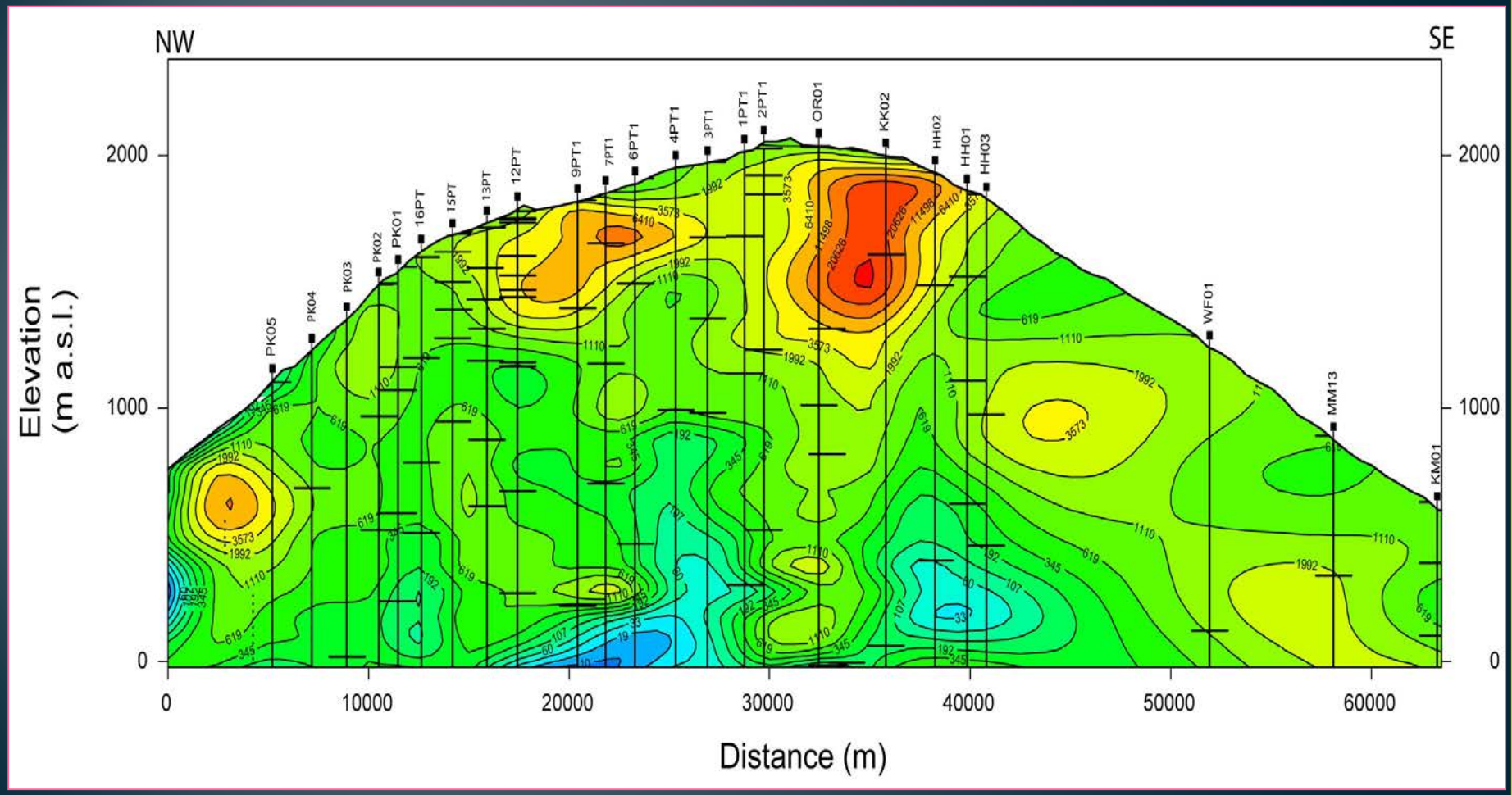
- Dense structures have greater gravitational pull
- These dense features may affect the flow of groundwater
- Particular interest
  - Saddle region
  - South of the Haulalai summit



Umikoa
Laupahoehoe
Papaaloa
Weloka
Ninole
Hakalau
Honomu
Pepeekeo
Papaikou
Hilo
Waikoloa
Ref
Waikii
Mamalahoa Highway
PK05
PK04
PK03
PK02
PK01
SR013
SR012
SRO11
SR010
SR009
SR008
SR007
SR006
SRO05
PTA3
PTA1
PTA2
PTA4
HSR2
MKR01
KK02
HH01
HH03
HH02
OR01
ML01
ML02
WF01
MM13
KM01
Hilo Forest Reserve
Laupahoehoe Natural Area Reserve
Hakalau Forest National Wildlife Refuge
Akaka Falls State Park
Kauku
Waikii Paddock Game Mgmt Area
Puu Nanaha
Puu Wekiu
Puu Papa
Pohakuloa Training Area Military Reservation
Hawaii
Waiakea Forest Reserve
Upper Waiakea Forest Reserve
Mauna Loa Forest Reserve
Puu Wahi
Pohaku o Hanalei
Puu Makaala
Mountain View
Puu Makaala Natural Area Reserve
Upper Olaa Forest Reserve
Hawaii Volcanoes National Park
Glenwood
19
Scale 1 : 325,000

What Are We Finding?

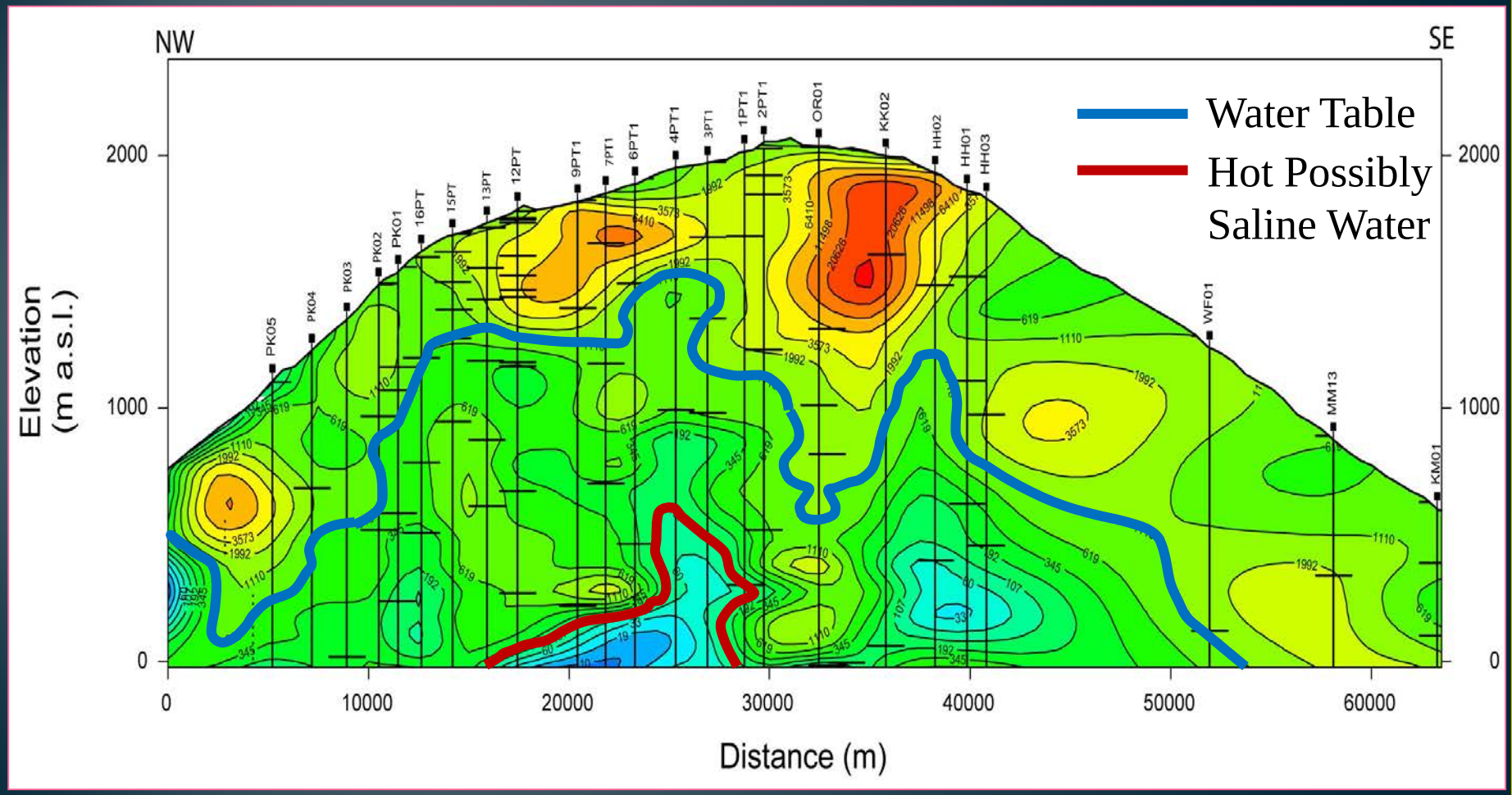
Electrical Resistivity



The likely occurrence of high level water

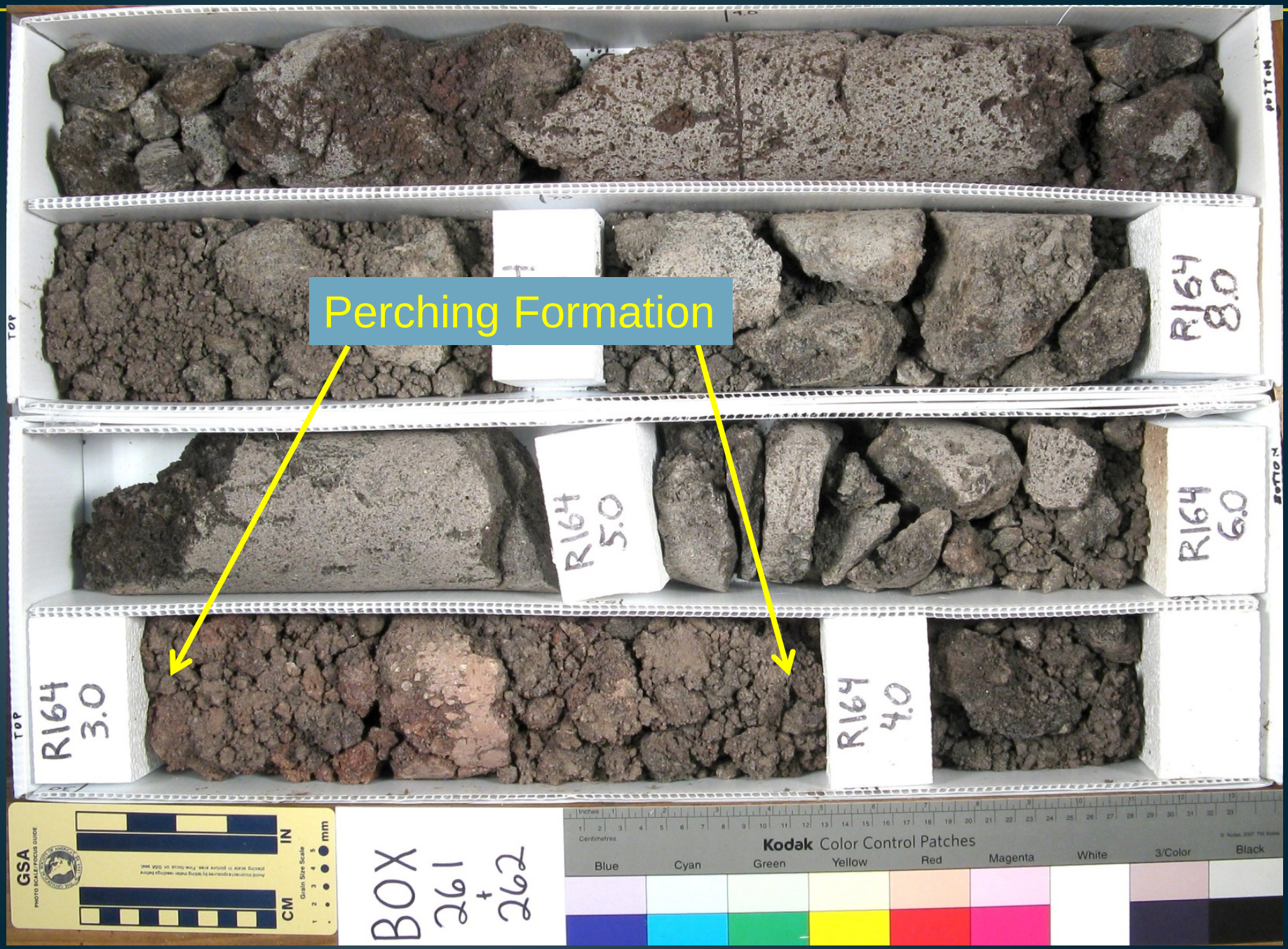
What Are We Finding?

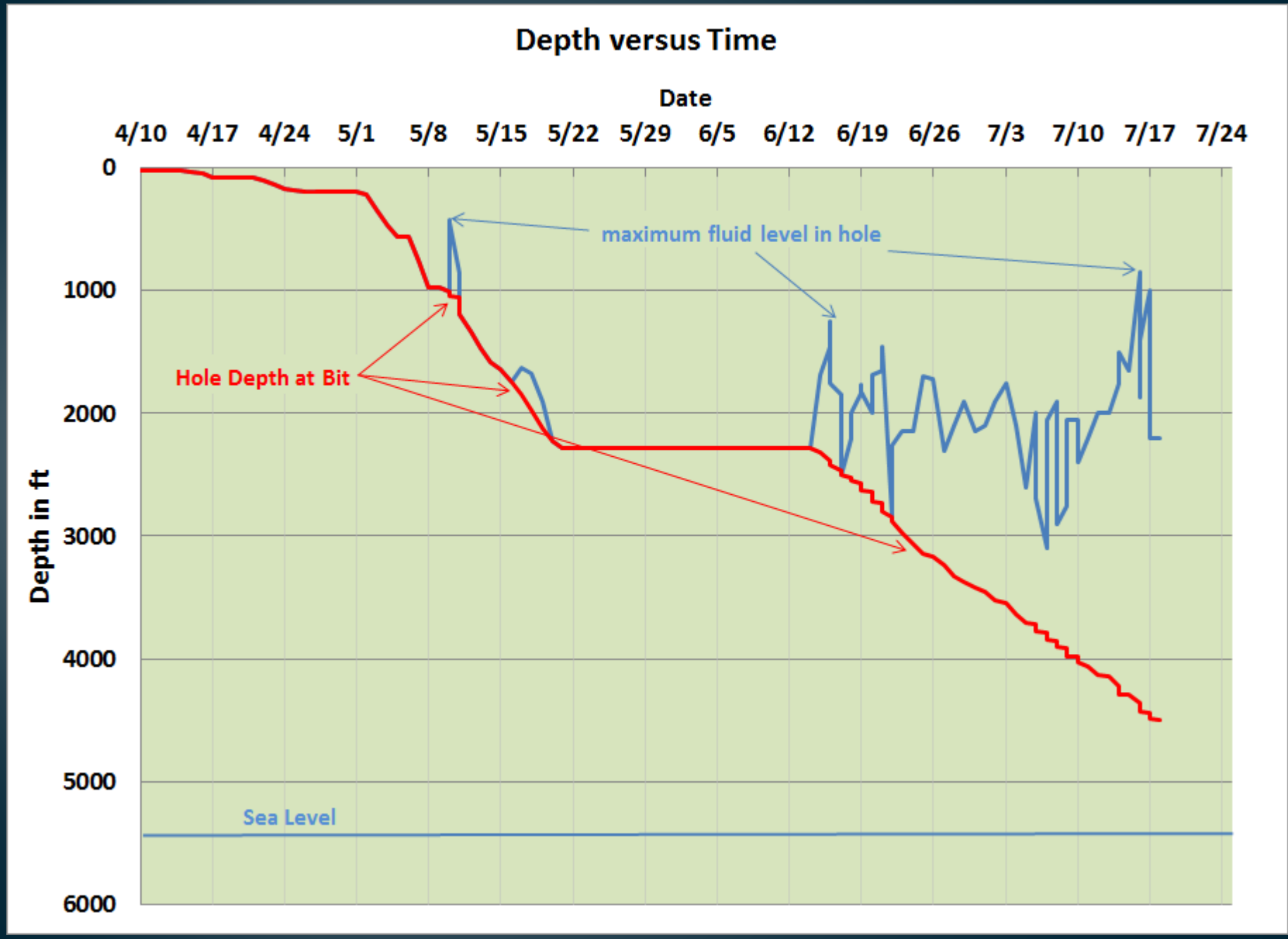
Electrical Resistivity



The likely occurrence of high level water

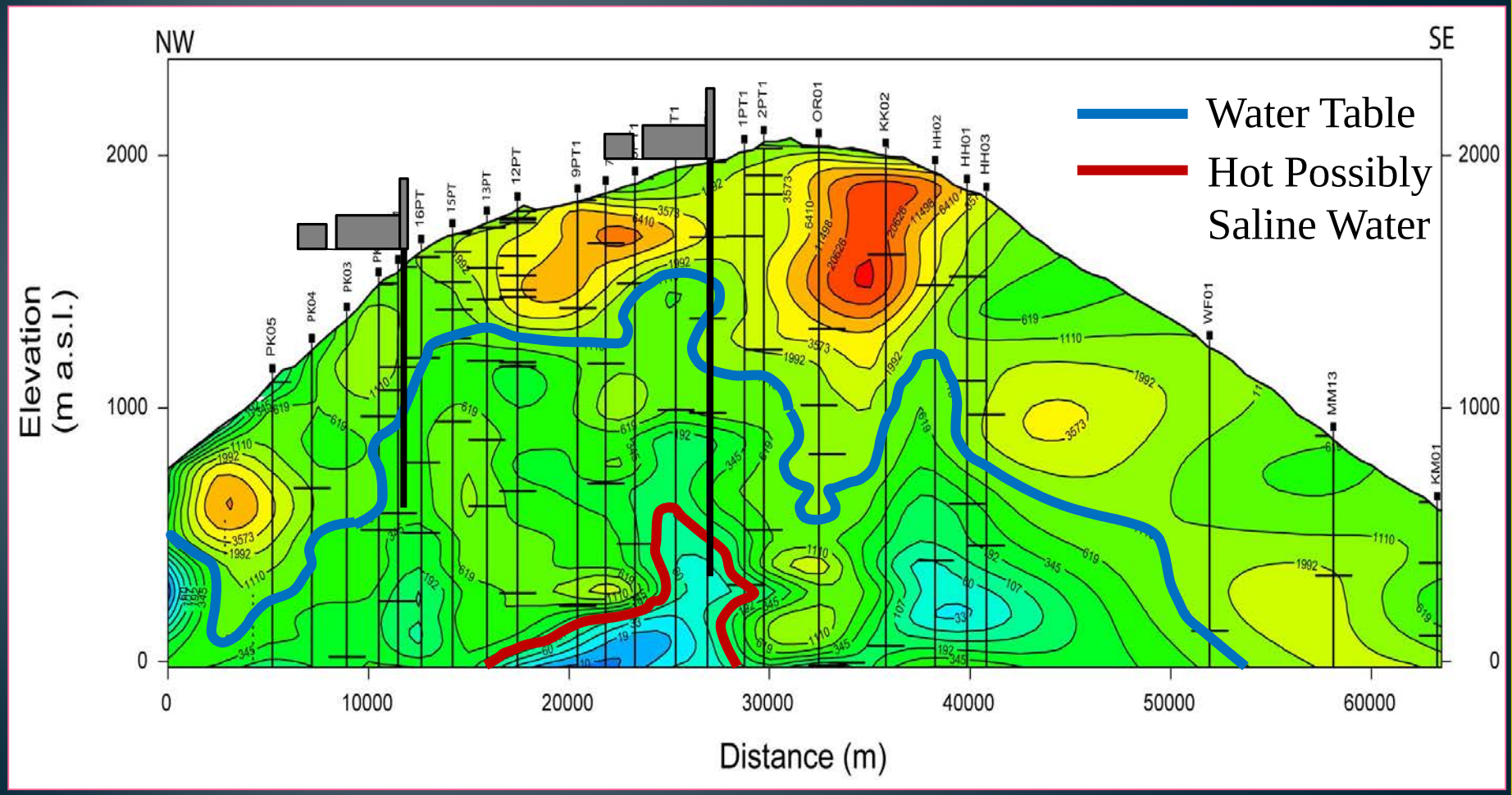
Exploratory Drilling Based on Geophysics Surveys


Perching Formation
R164 8.0
R164 5.0
R164 6.0
R164 3.0
R164 4.0
TOP
BOTTOM
BOX 261 + 262
GSA
Kodak Color Control Patches
Blue
Cyan
Green
Yellow
Red
Magenta
White
3/Color
Black


Depth versus Time
Date
4/10
4/17
4/24
5/1
5/8
5/15
5/22
5/29
6/5
6/12
6/19
6/26
7/3
7/10
7/17
7/24
Depth in ft
0
1000
2000
3000
4000
5000
6000
maximum fluid level in hole
Hole Depth at Bit
Sea Level

What Are We Finding?

Drilling confirmed geophysical findings



High level water on top, heated water at depth

What Does This All Mean?

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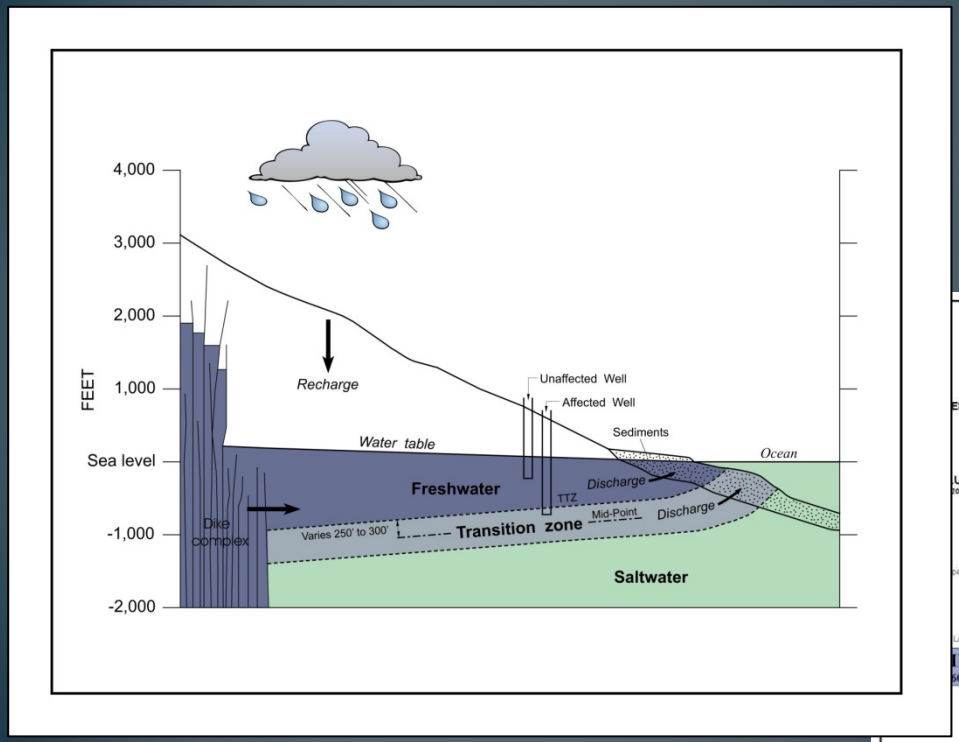
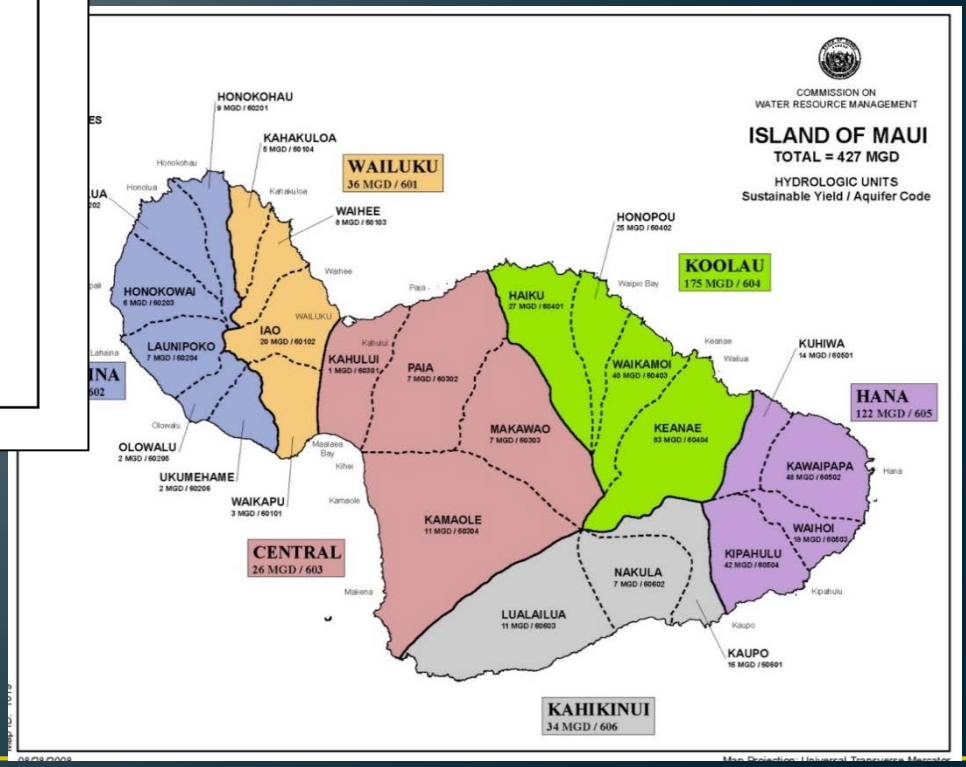
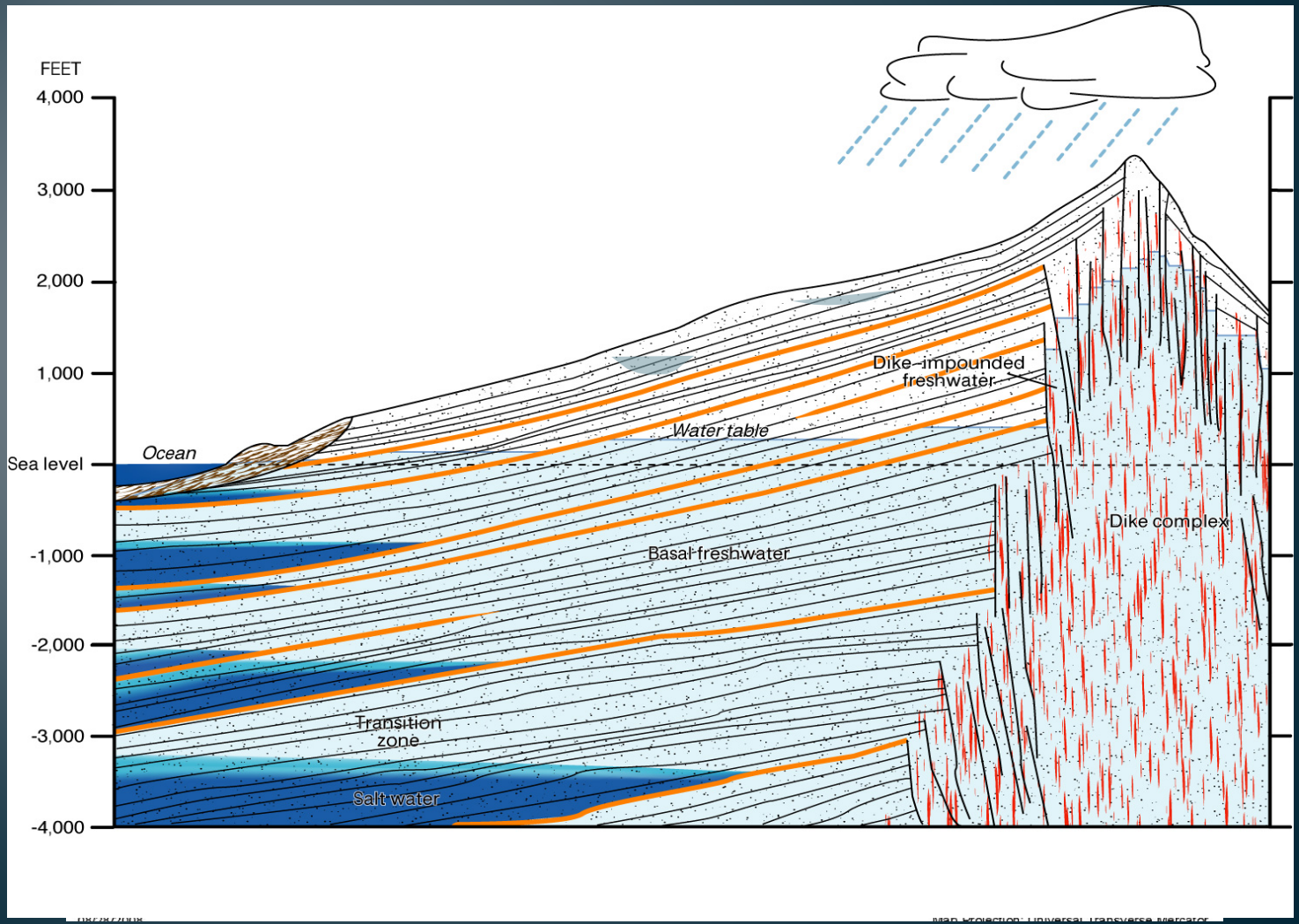
We manage based on these conceptual models





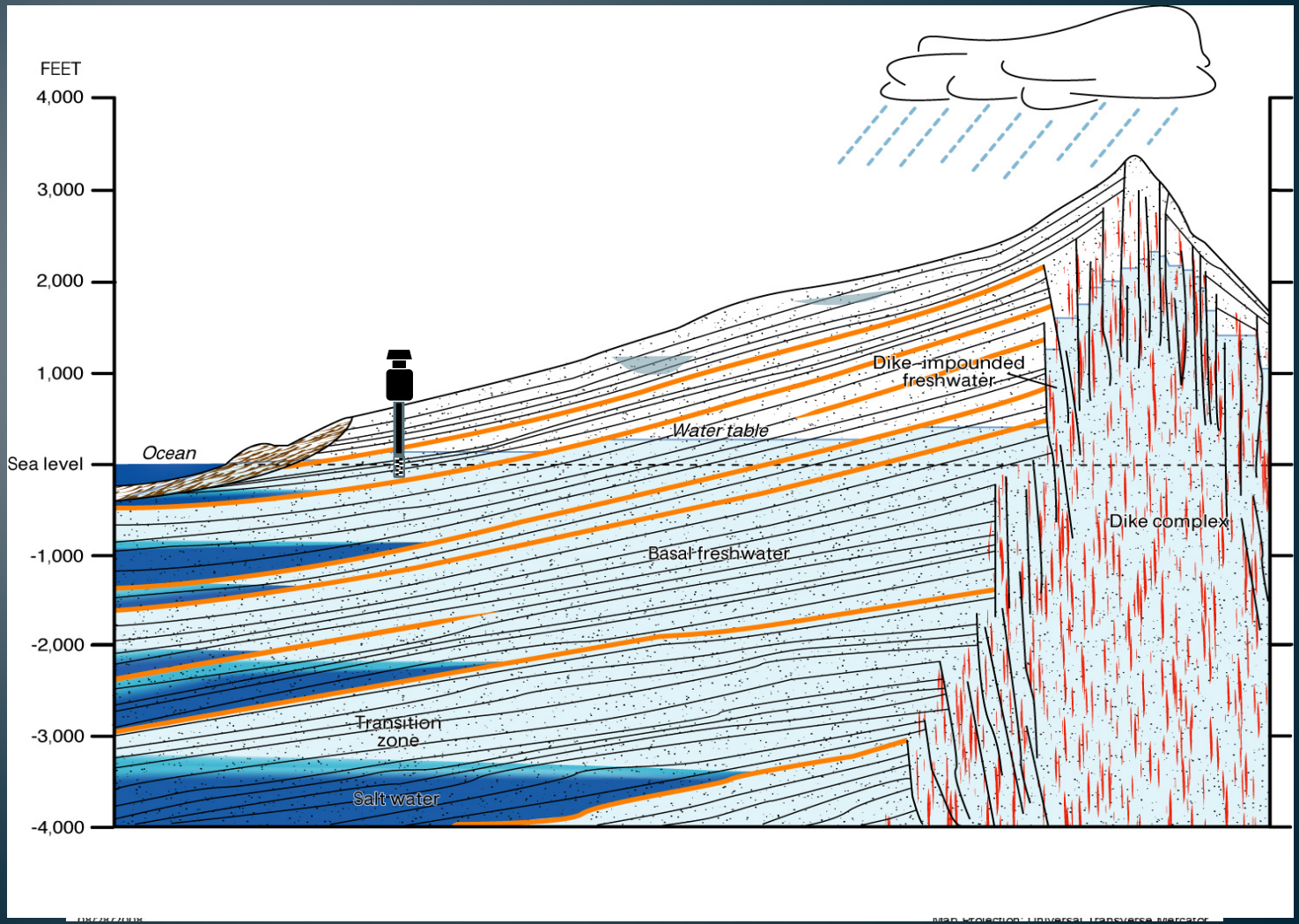
What Does This All Mean?

When perhaps we should manage based on this conceptual model



What Does This All Mean?

Sustainable yield considerations!



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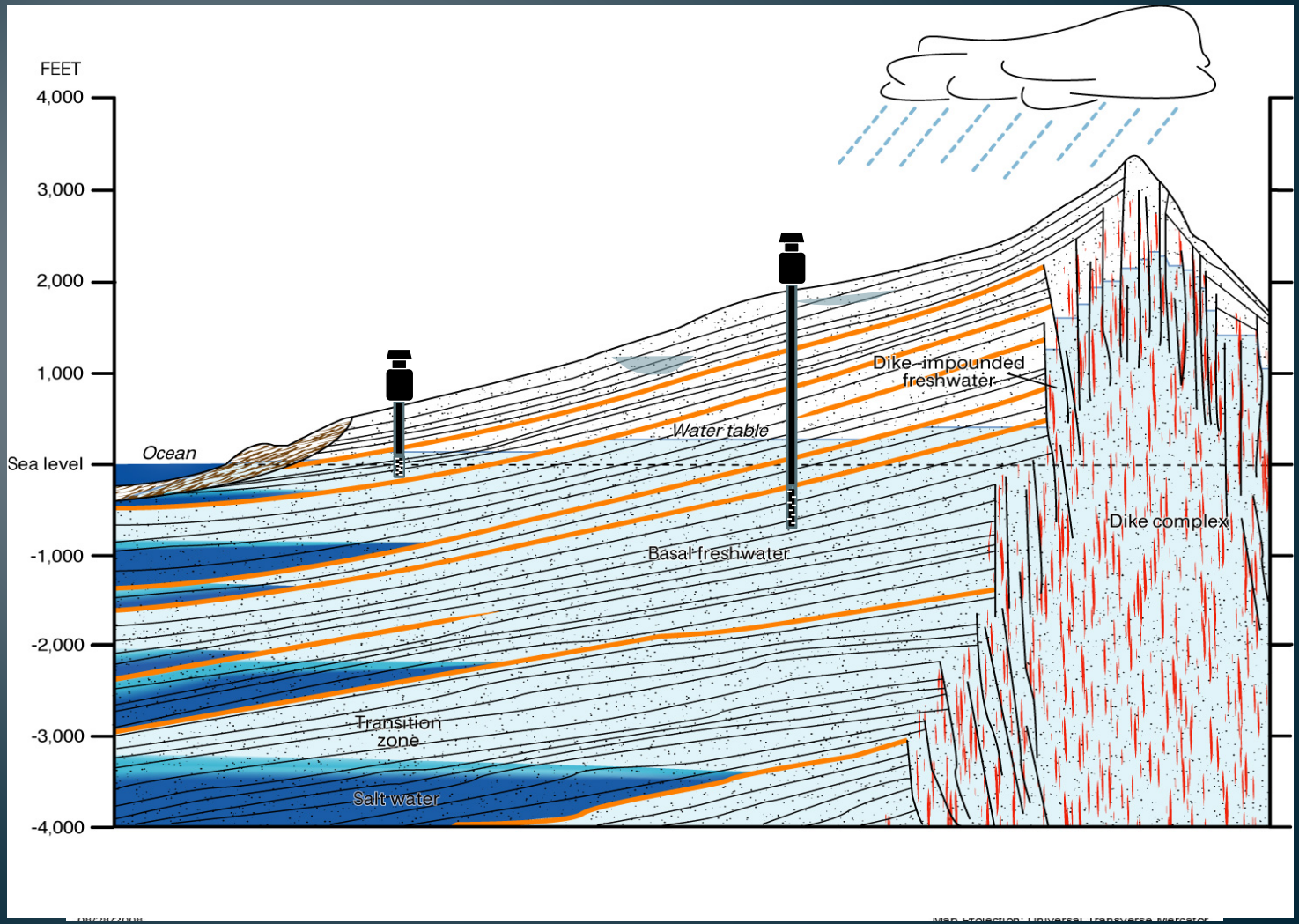
Sustainable yield considerations!
Source water protection considerations



What Does This All Mean?

Sustainable yield considerations!
Source water protection considerations!

Changing our management approach requires a solid scientific basis that comes with Academic/Agency collaboration to fully understand the occurrence of Hawaii's groundwater

EPSCOR

- Experimental Program to Stimulate Competitive Research
- Develop a collaborative effort among the UH, CWRM, DOH, and county DWS to:
  - Better define the distribution and extent of groundwater aquifers statewide
  - Develop better models for groundwater flow that can more reliably project the rates and direction of flow of the groundwater (and potential contaminants)

"…we still don't have an understanding of the groundwater system. There's nowhere near enough outflow in the surface waters to balance the recharge…" MacDonald, 1974

How Do We Propose To Do This

- **Geospatial Database**
  - Compile “legacy” data into geospatial database
  - Use data to develop suite of visualization tools
- **Geophysics**
  - Conduct geophysical surveys of suspected groundwater barriers and at monitoring wells
  - Apply geophysical methods to contaminant problems
- **Geochemistry**:
  - Use as novel tracers
  - Monitor in real time with downhole monitoring instruments
  - Improve estimates of coastal discharge
- **Input acquired data into 3D groundwater models**

How Do We Propose To Do Thi$

- NSF proposal that would allow us to accomplish these goals in the Keauhou/Kiholo and Pearl Harbor/Honolulu aquifers
- Provide funding for interns, field work, development of the visualization software, monitoring tools, models, etc.
- Also working on a proposal to DOD for site specific work in the Pearl Harbor area

Collaboration Across Programs and Agencies

- Acquire legacy data and clear guidance on (C.I.) access restrictions
- Agree on the types of monitoring that would be most beneficial
- Identify a subset of wells that can be monitored
- Agree on what mapping or sorting capabilities would be most useful to potential users

What is the Desired End State

- A better understanding of the groundwater flow and storage inside the islands
- A suite of useful, user-friendly data tools for agency and research staff
- A set of data visualizations that will allow the agencies to better convey the condition of our groundwater resources (and the threats thereto) to the public and decision-makers
- More robust modeling capabilities that can reliably reflect storage and transport processes and can support agency needs (e.g. SWAP, contaminant plume definition)
- **Train future groundwater science professionals!**

Does this need for new science mean as State Agencies and Water Systems We Are We Negligent in our Duties?

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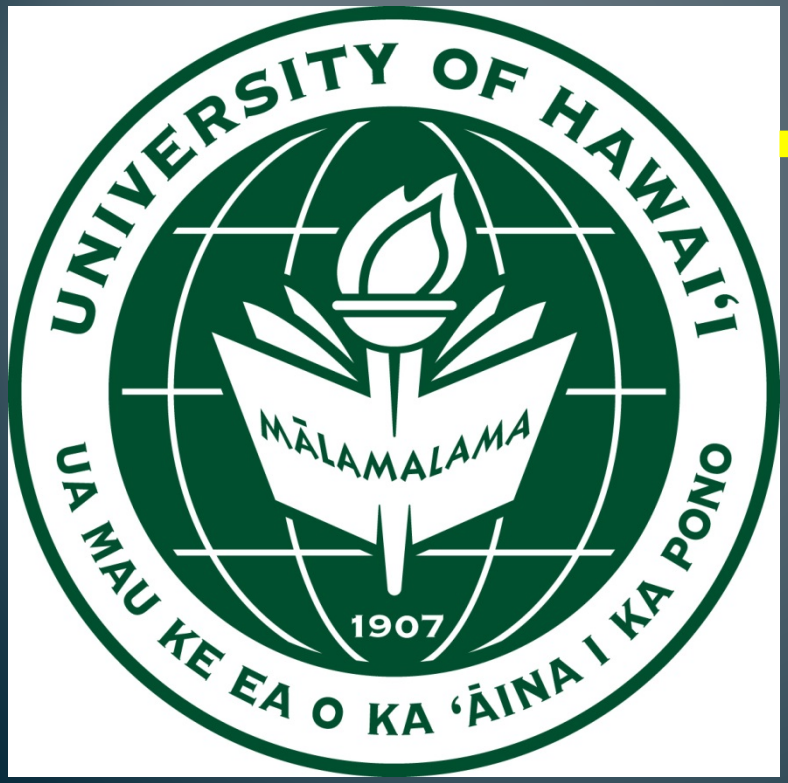
NO!!!!!!

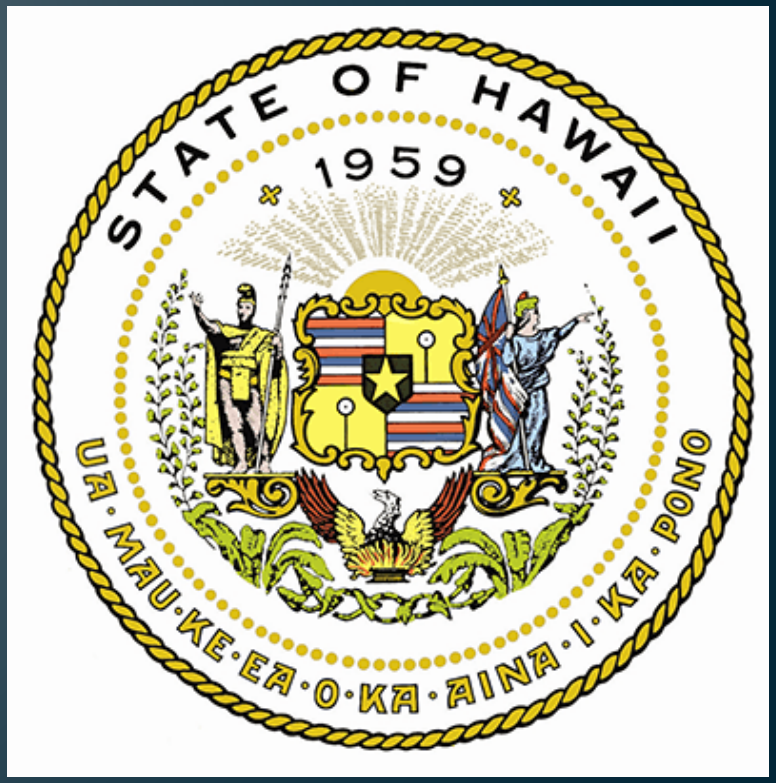
Does this need for new science mean as State Agencies and Water Systems We Are We Negligent in our Duties?

NO!!!!!!

- We work full time (plus) to manage and protect our valuable groundwater resources
- But, we need the assistance of best scientific minds
- We as State Agencies can also provide valuable insight on the science and the issues

Knowledge is a Two Way Street!





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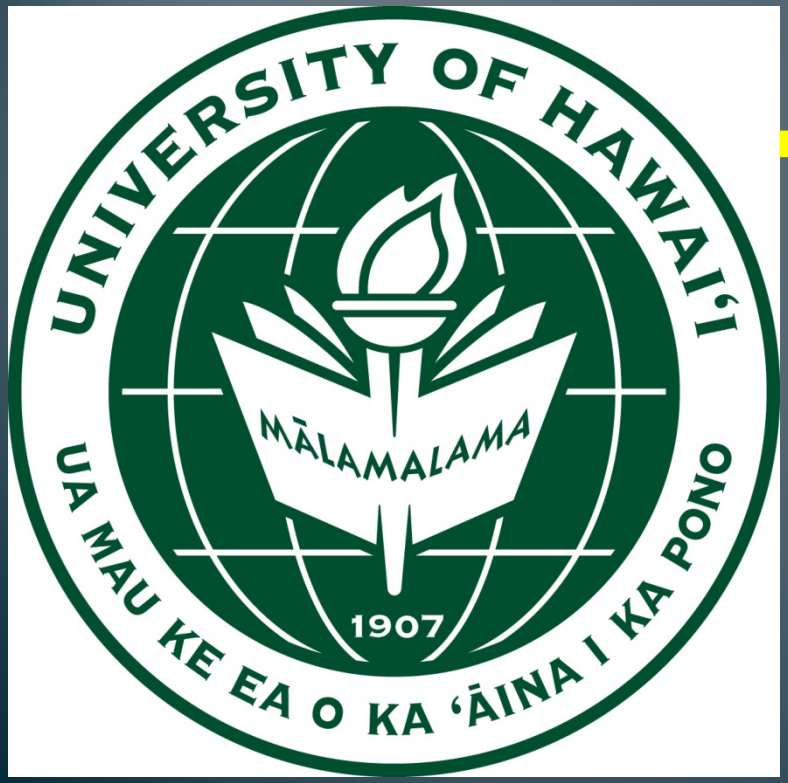
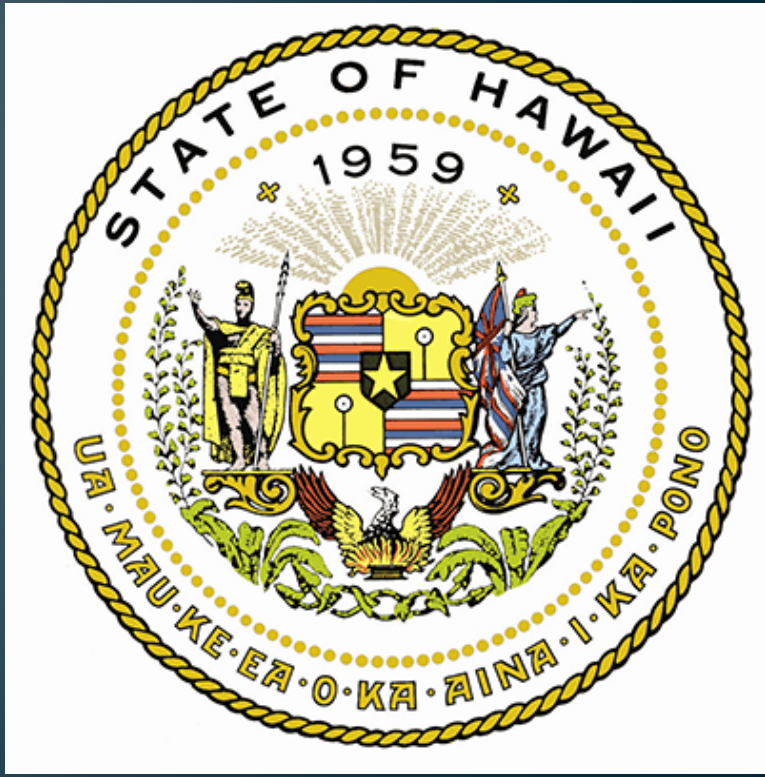


- Cutting edge scientific knowledge
- High tech resources;
- Highly skilled research staff!

Knowledge is a Two Way Street!

- Operate on the front lines;
- Know the issues;
- See how things work; and
- Provided technical support for the EPSCoR Proposal



Academic/Agency collaboration is not a new concept!

We have been doing it for quite some time!

Examples

- Pesticide licensing evaluation model (Stenemo et al., 2007);
- Sustainable yield model (Liu et al, 2012);
- Wastewater Training Center (R. Babcock);
- Coastal nutrient flux studies (C. Glenn and the Submarine Groundwater Discharge Group);
- Source Water Assessment Program;
- On-site sewage disposal system study;
- The Lahaina groundwater tracer study; and
- Many others

GOAL

Move the Academic/Agency collaboration from the project level to one of public policy!

PAU!