Geothermal Research in the CNMI and the Region's Timetable

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Presented by James E. Quick
Special Assistant to the Governor of the CNMI for Alternative Energy
Professor of Geology, Associate Vice President for Research, and Dean of Graduate Studies, SMU

Summarizing results of a geothermal assessment in progress by David Blackwell, Al Waibel, Leyland Roy Mink, and Maria Richards of the SMU Geothermal Laboratory

Plan for the long term….

but act immediately!

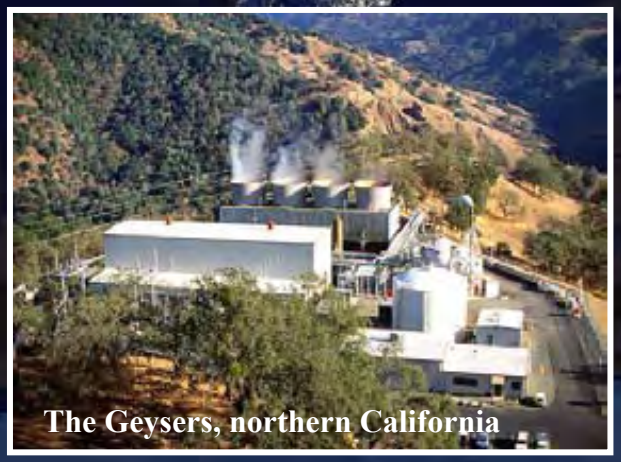
Micronesia will require a mix of solutions.

- Conservation / Efficiencies
- Solar Power
- Wind Power
- Geothermal Power
- Biofuel
- Power generation from solid waste.
- Ocean Power: currents, tides, waves, OTEC

The CNMI is unique in Micronesia in having abundant geothermal energy.

Geothermal power is:

- Reliable "base-load" generation of electricity
- Modular, incremental development
- Renewable and sustainable
- Cost-competitive
- Clean and safe
- Proven



The Geysers, northern California

Capacity Factors	
Geothermal	0.90
Biomass	0.83
Solar Thermal	0.82
Wind (Onshore)	0.44
Wind(Offshore)	0.40
Photovoltaic	0.21

Source: DOE Report #EIA-0554(2009)

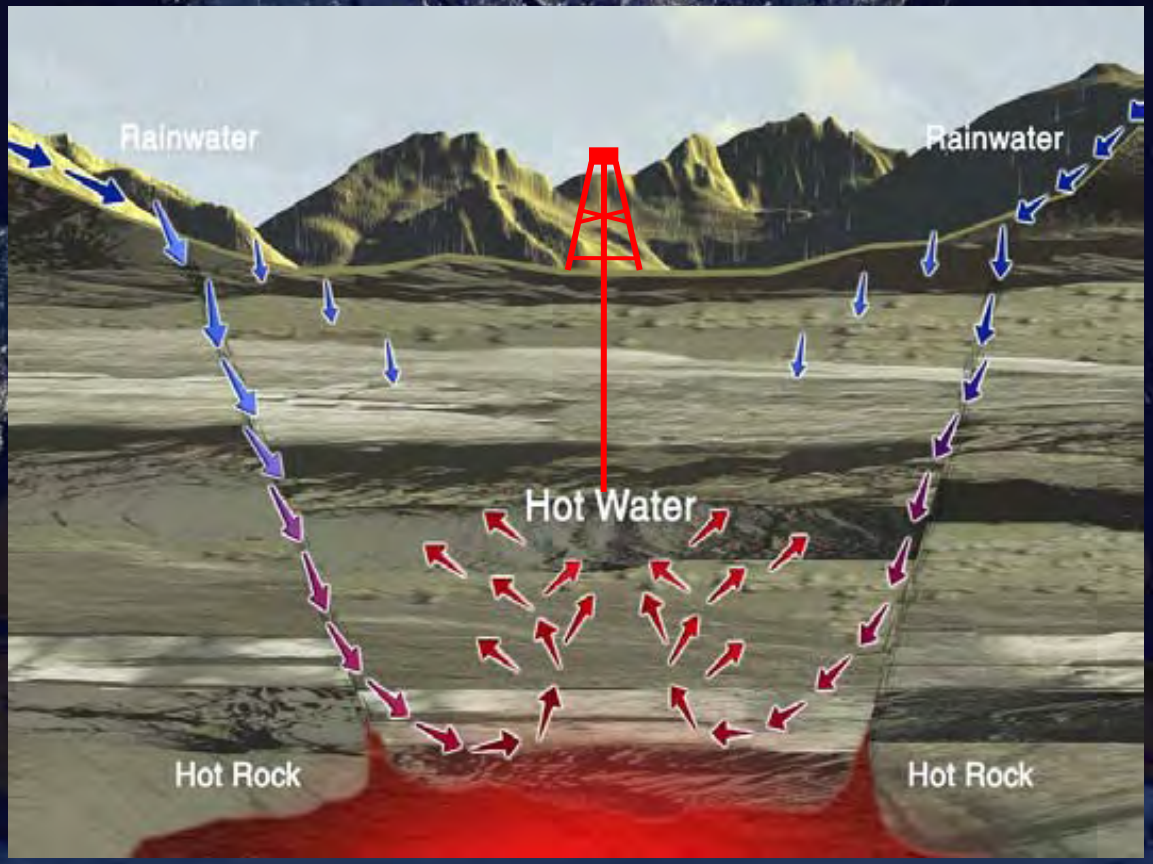
Cost ($ / kW)	
Geothermal	4,301
Biomass	3.636
Solar Thermal	1,778
Wind (Onshore)	1,865
Wind(Offshore)	3,707
Photovoltaic	5,189

Source: DOE Report #EIA-0554(2009)

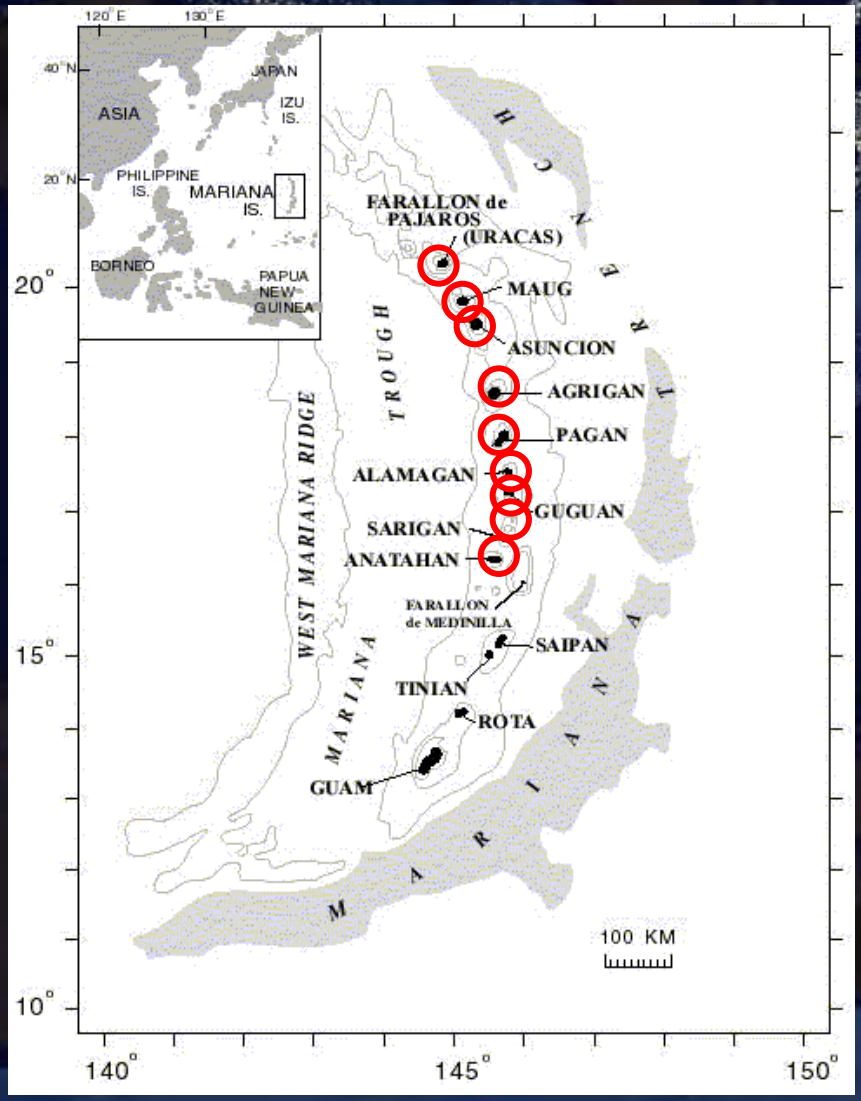
Requirements to develop geothermal power

1) Hot Rocks

2) Hydrothermal Circulation



Why Consider Geothermal Energy in the CNMI?



Nine islands north of Saipan host active volcanoes.

Clearly, the heat is there!

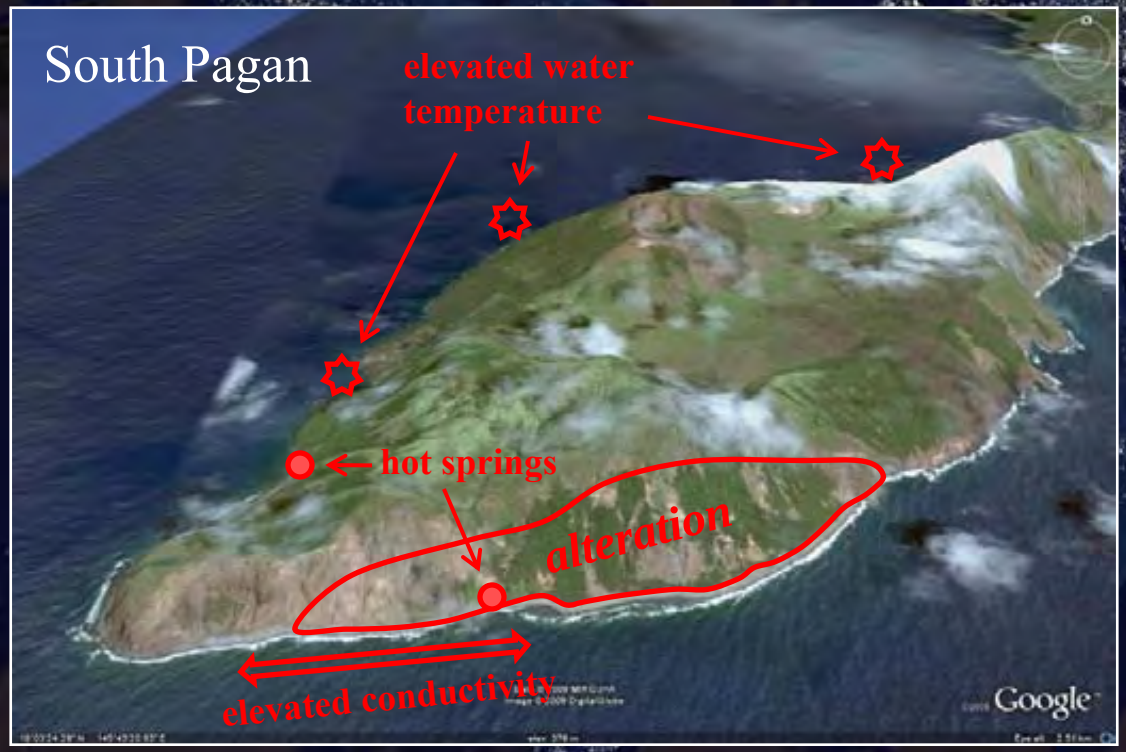
But is there hydrothermal circulation?

To answer this question, a geothermal assessment of Pagan was completed in 2008 by

David Blackwell
Al Waibel
Leland Roy Mink
Maria Richards

of the
SMU Geothermal Laboratory

Assessment Results on Pagan:

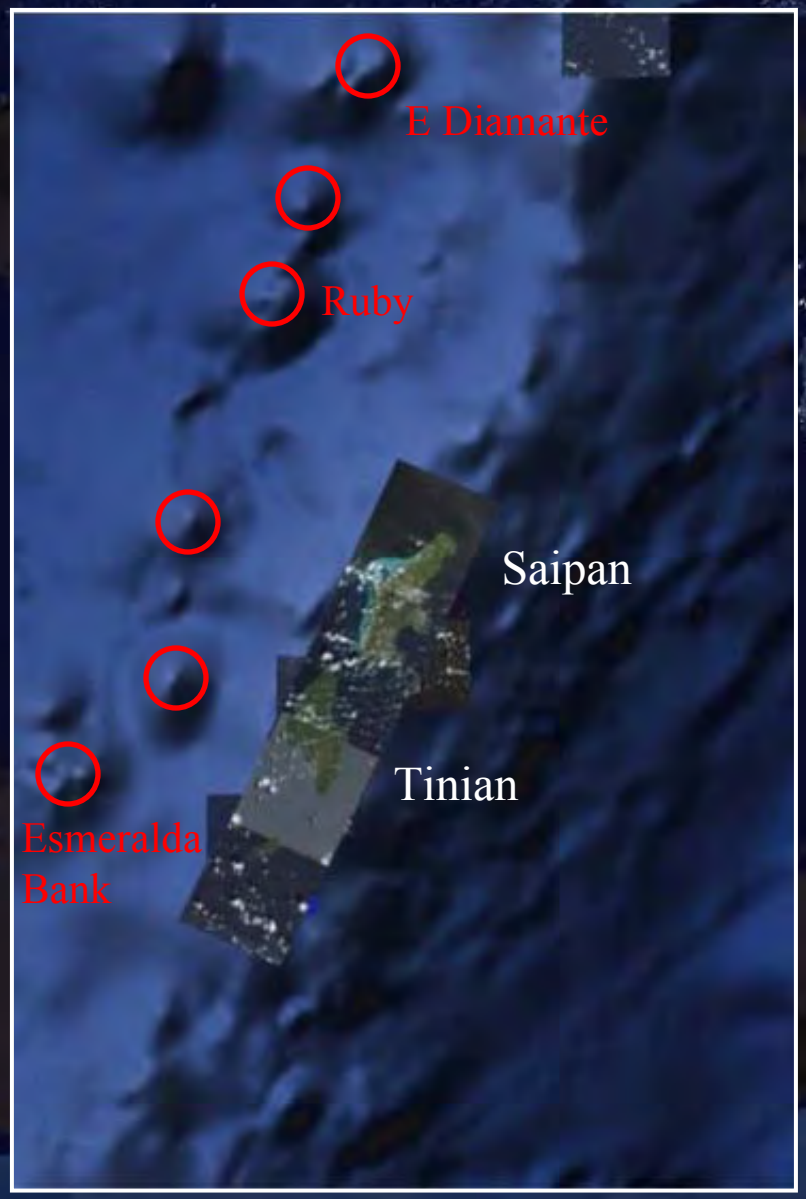


Evidence of hydrothermal circulation on South Pagan:

- Hydrothermal alteration
- Hot springs
- Evidence of submarine springs (NOAA, 2007)

Based on the size of the hydrothermal system and the chemistry of the springs, a geothermal reservoir exists on South Pagan with an estimated generating capacity of 50 – 125 MW!

Why Consider Geothermal Energy on Saipan?



Several observations suggest that Saipan may also have geothermal potential:

- Proximity to active volcanoes

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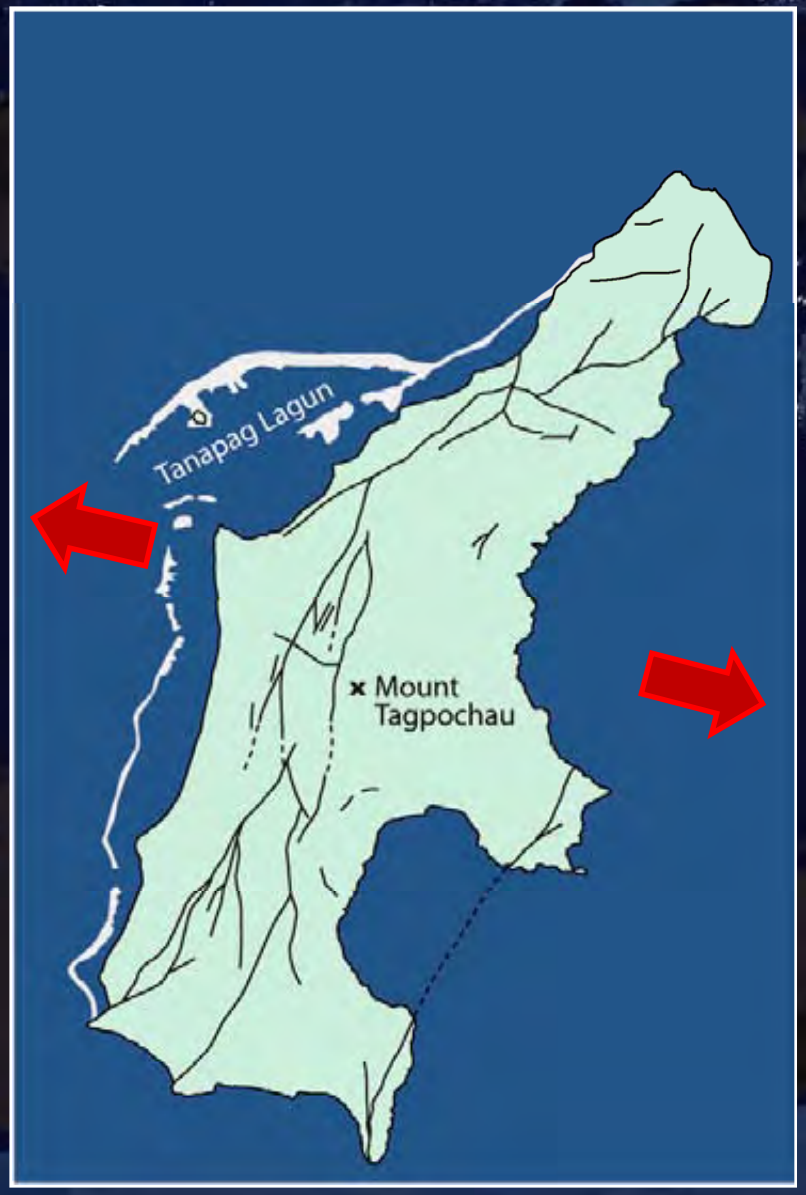

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- Proximity to active volcanoes
- Extensional faulting

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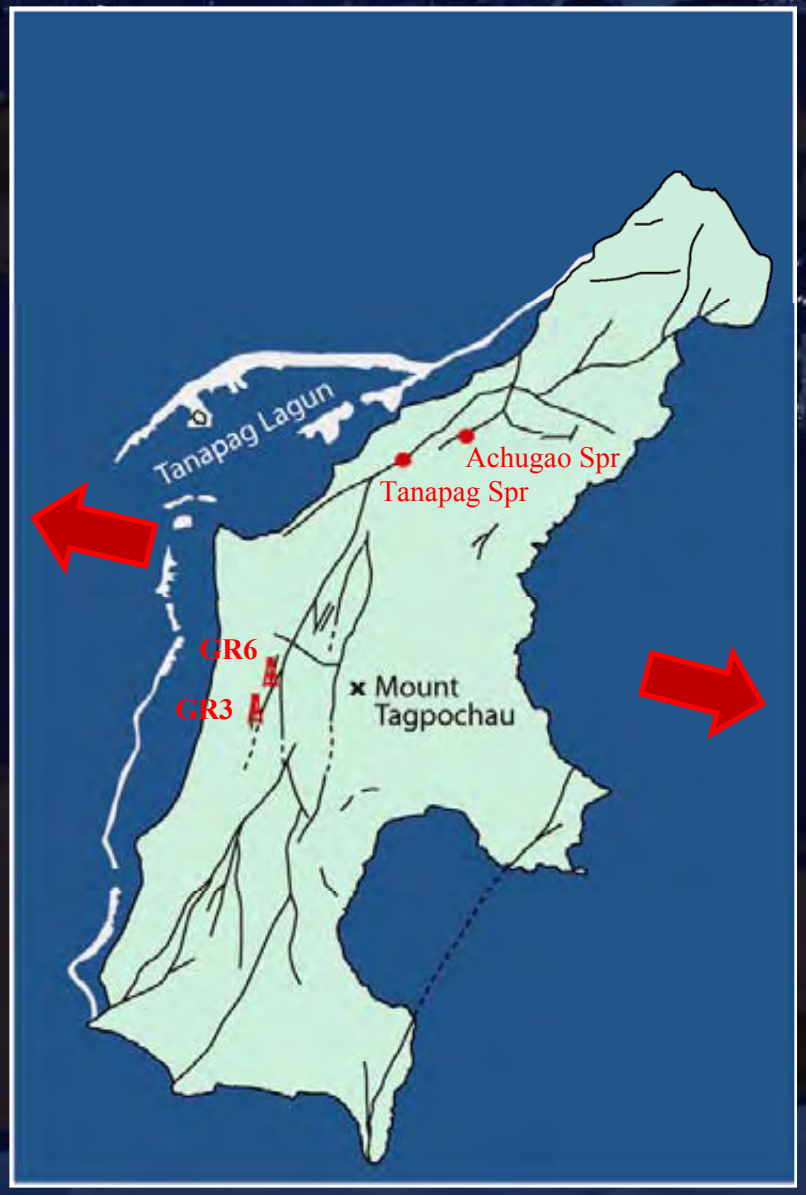
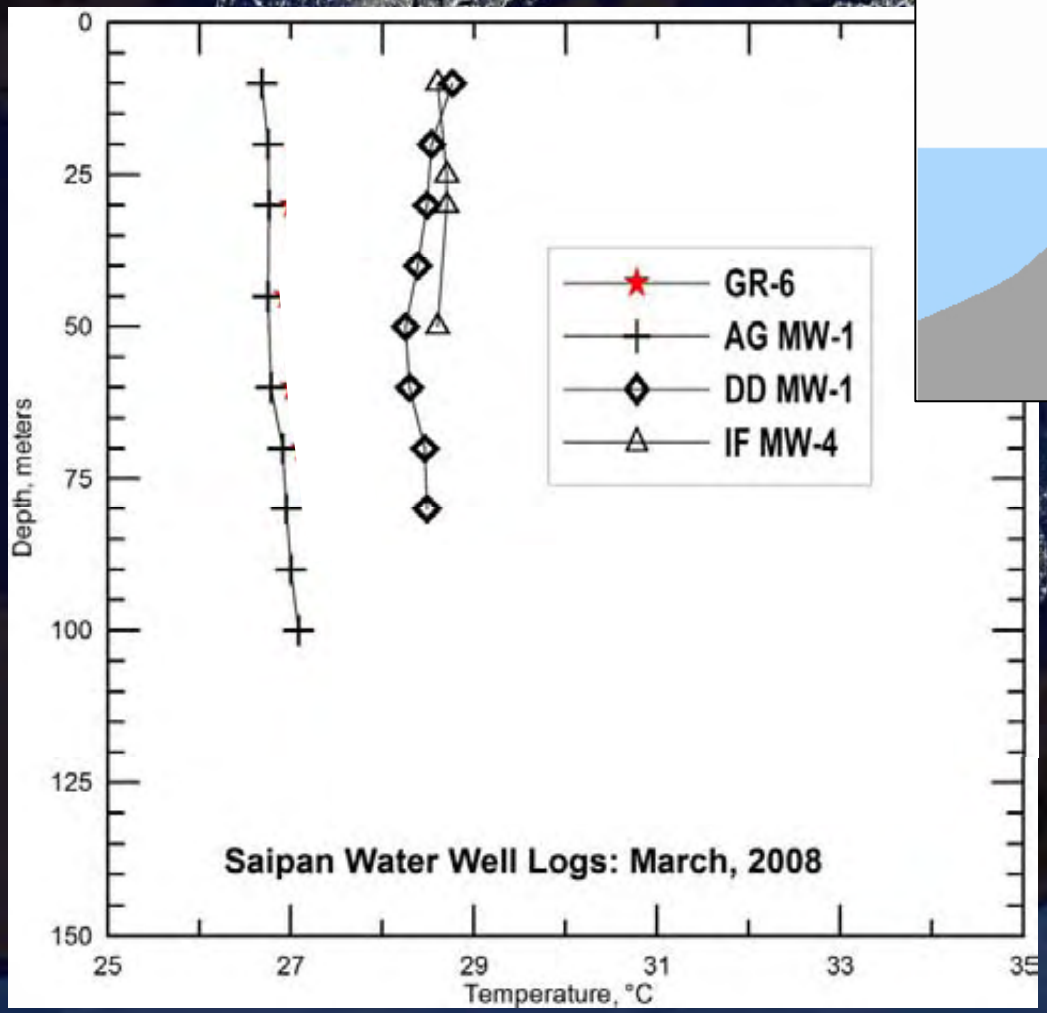


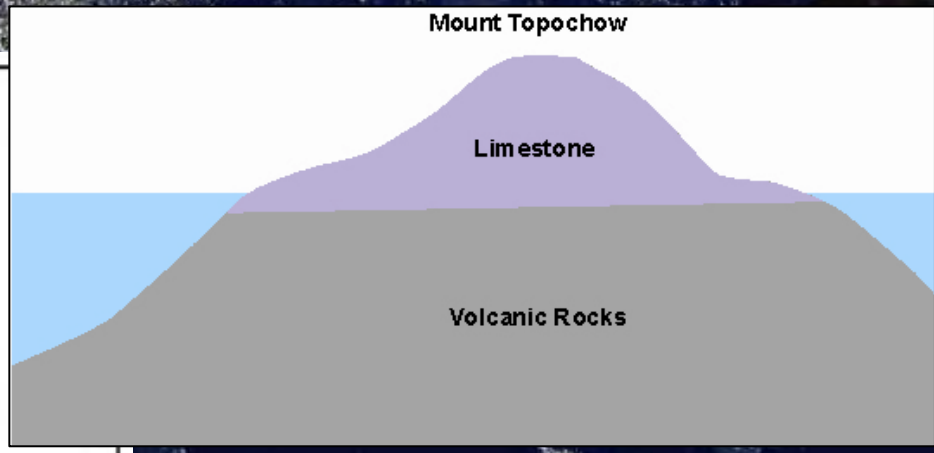
Several observations suggest that Saipan may also have geothermal potential:

- Proximity to active volcanoes
- Extensional faulting
- Elevated temperatures in wells GR6 and GR3.

Results to date on Saipan:

confirmation of local elevated temperatures in wells





Most water wells do not penetrate below the limestone that caps Saipan.

Temperatures in these well are low and relatively constant.

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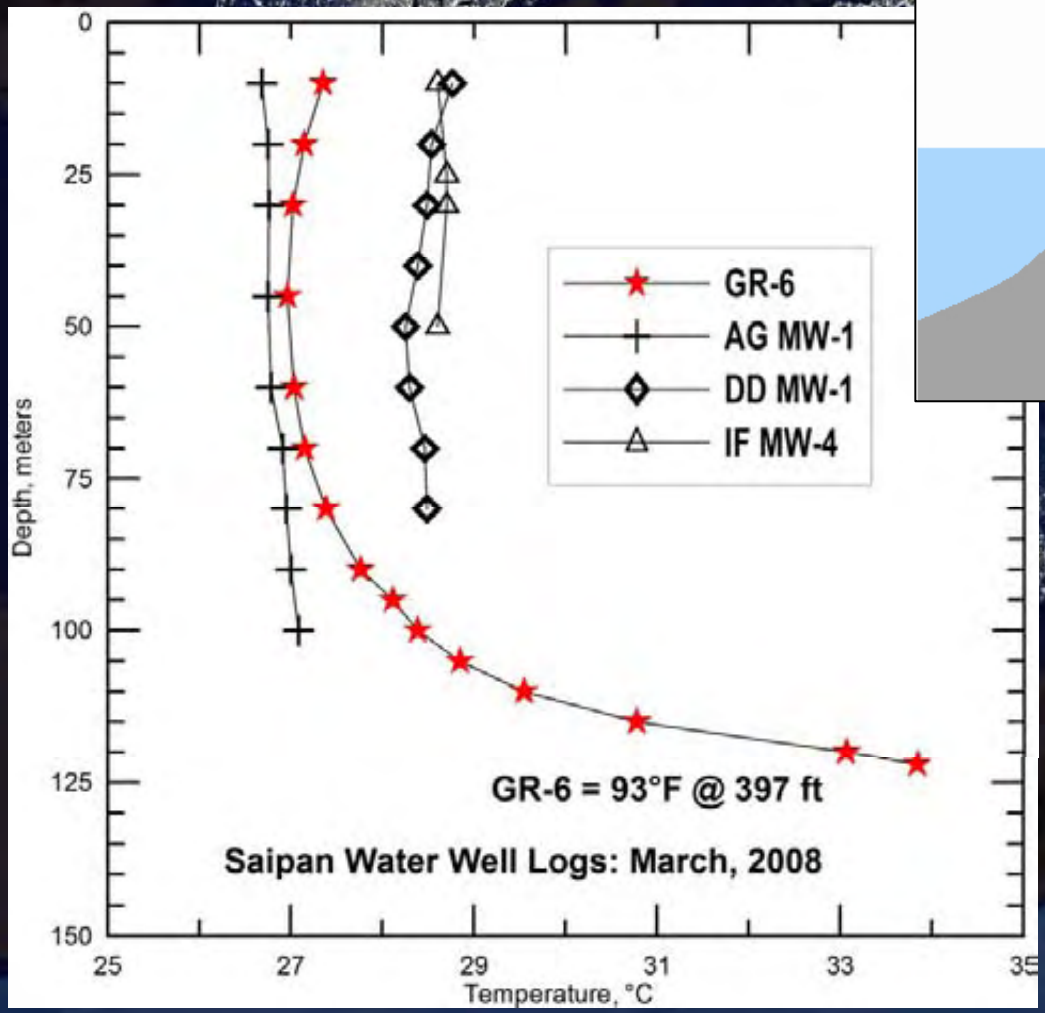
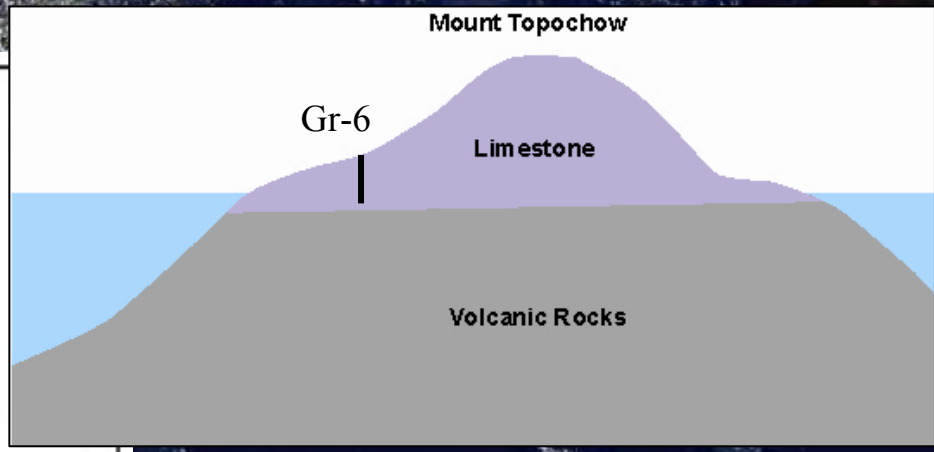
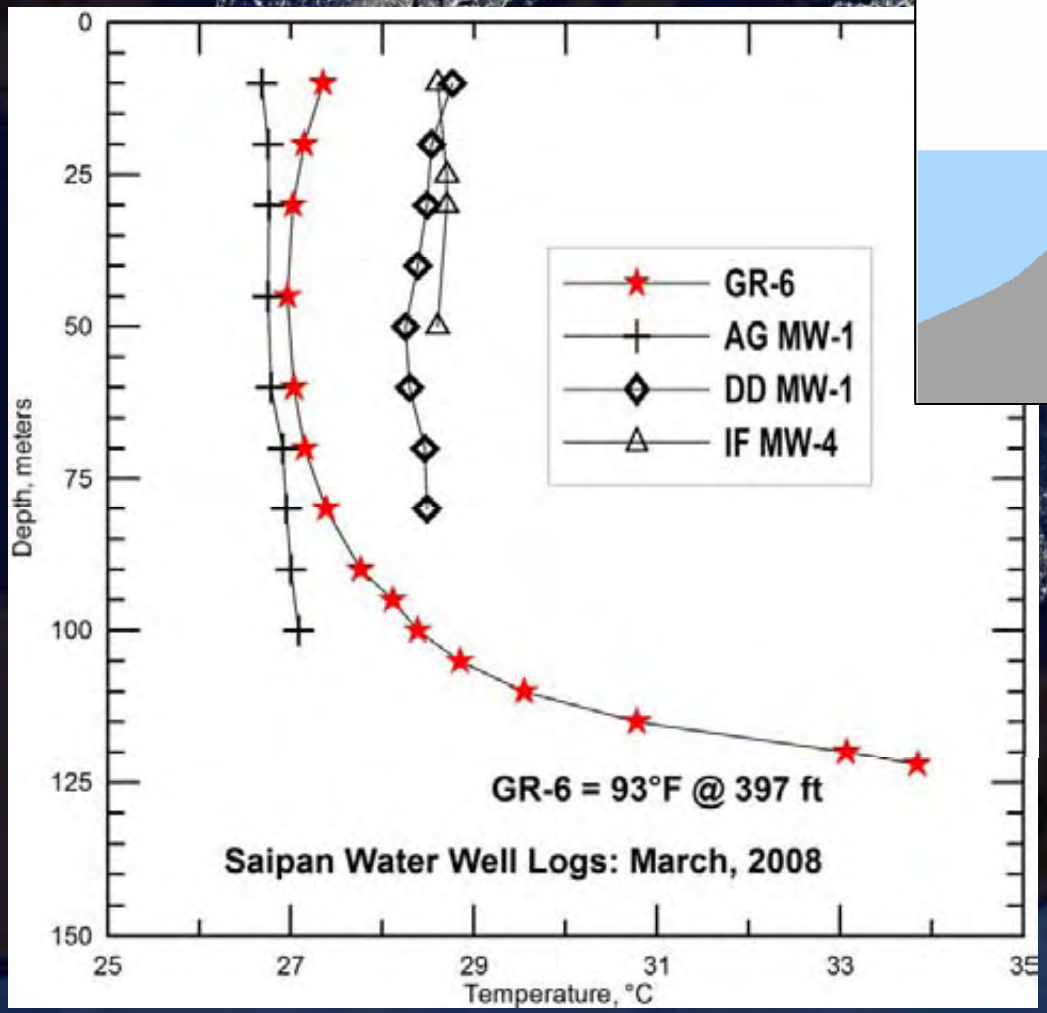


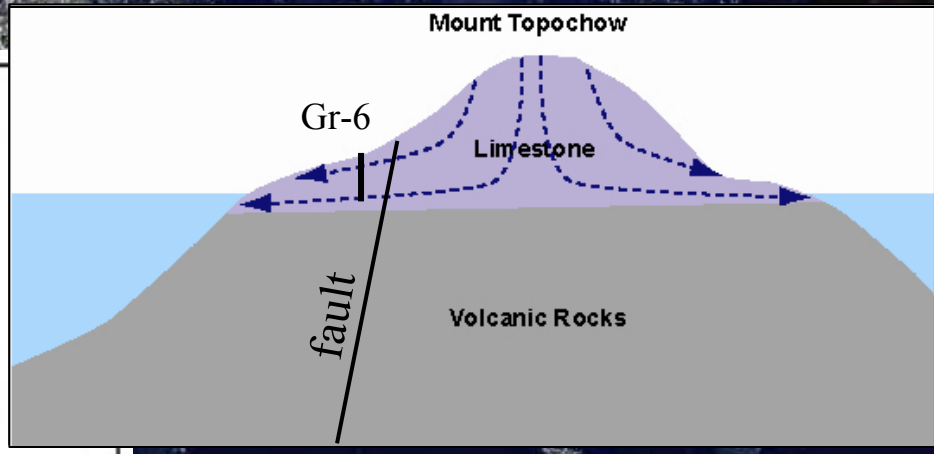


One drill hole on the west side of Saipan show sharply increasing temperature with depth.

Results to date on Saipan:

confirmation of local elevated temperatures in wells





Interpretation

Temperatures in most water wells are controlled by rainwater moving rapidly through the limestone.

Well GR-6 temperatures are affected by deeper hydrothermal circulation along a deep fault.

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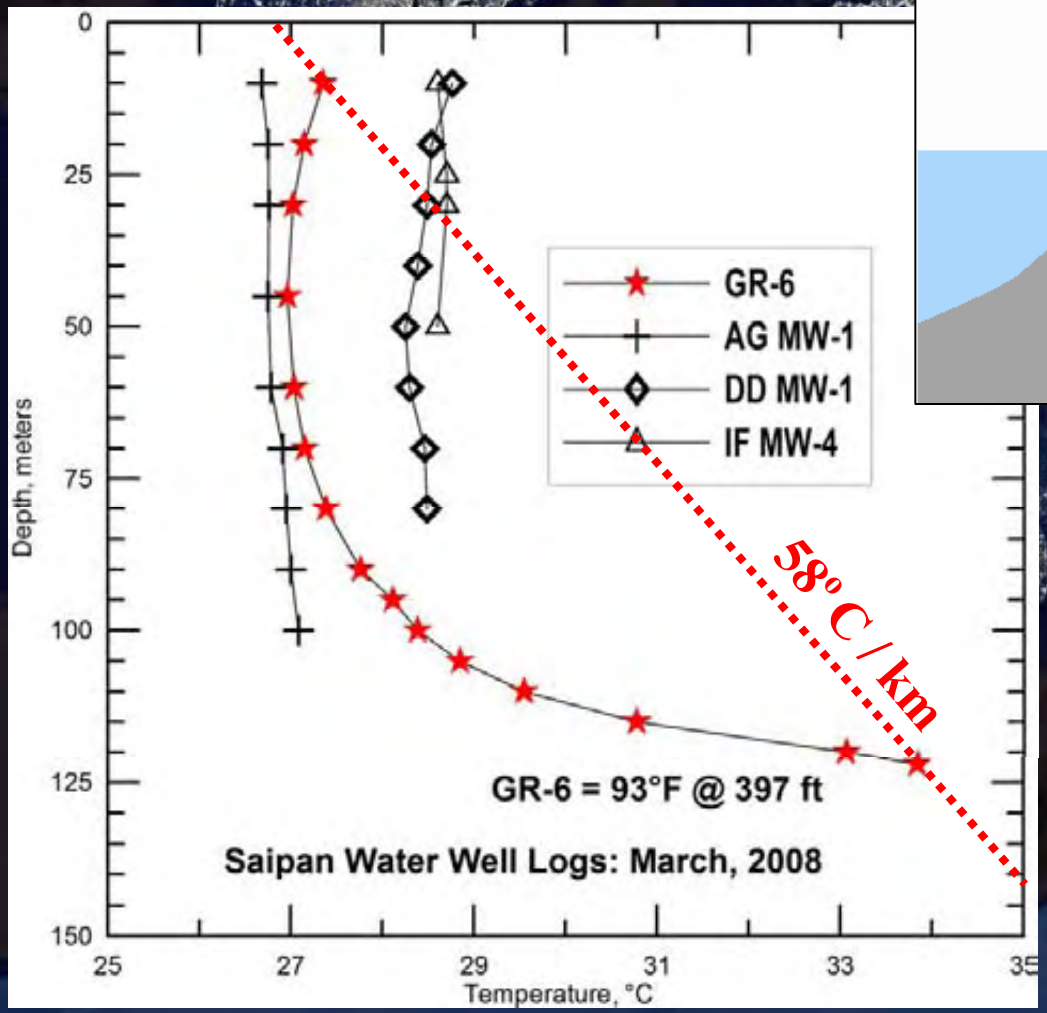
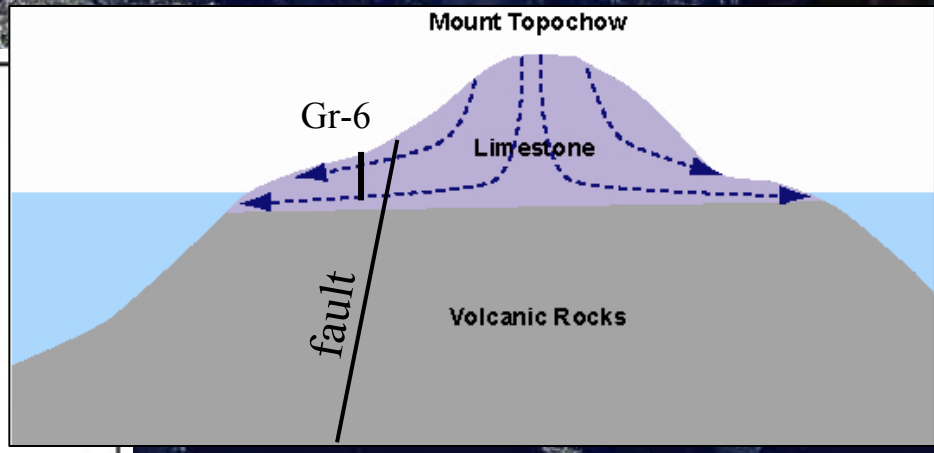
confirmation of local elevated temperatures in wells





The GR-6 temperature profile suggests that a steep geothermal gradient may exist beneath Saipan.

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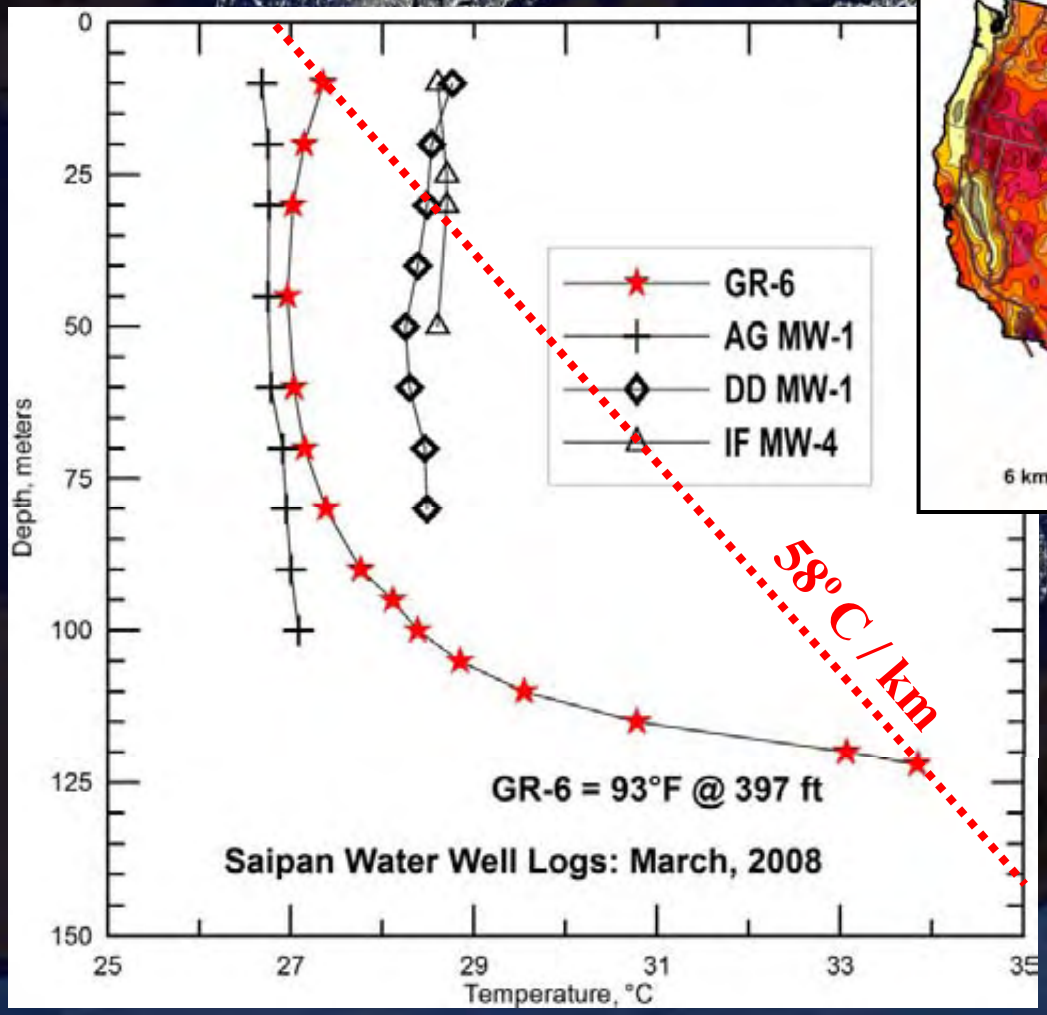
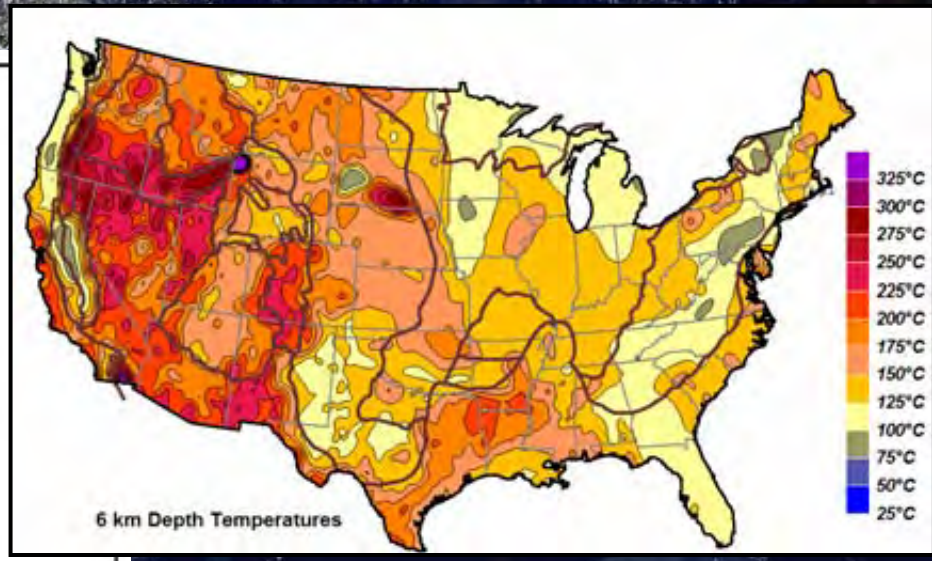




This gradient is comparable to the more promising geothermal regions in the Mainland.

Current Status and Implications

Pagan: observations indicate a high probability of high-temperature geothermal resources on the order of 50 to 125 MW

Implications:

- Geothermal energy could support development and resettlement of Pagan in the near term.
- Looking to the future, geothermal energy at Mariana volcanoes could be transported to Saipan and Guam via submarine electrical cable.
- As a hydrogen economy develops, the CNMI could be an exporter of energy.

Saipan: available observations increase the probability of geothermal resources exploitable by binary technology

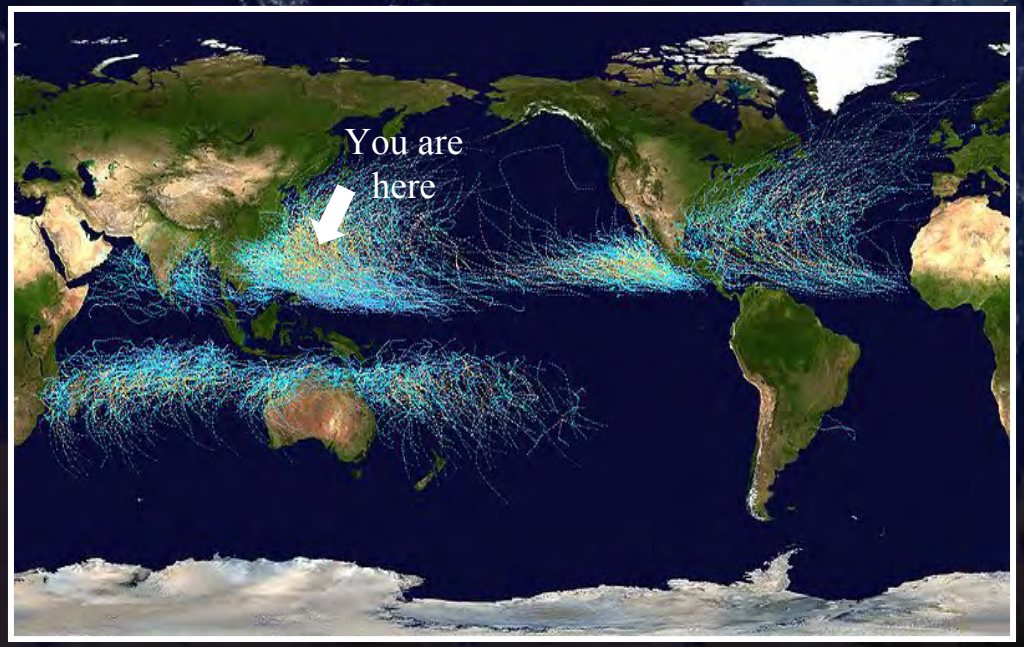
Drilling of a 2,000 foot hole is required to accurately measure the temperature gradient and to sample fluids.

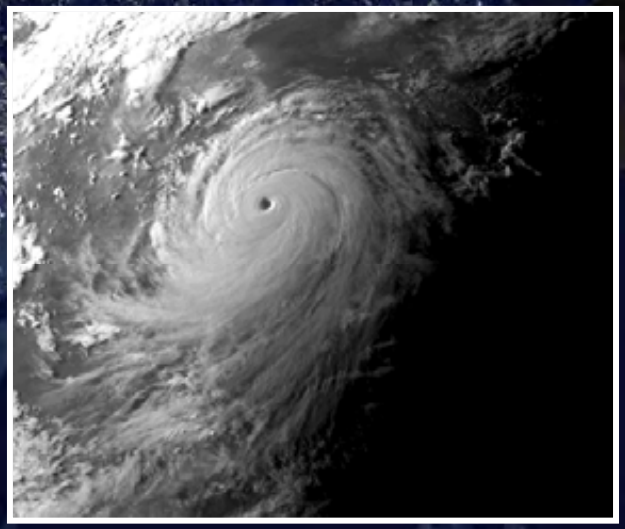
Implications:

- Binary power plants using conventional or EGS technology would diminish Saipan's dependence on fossil fuel for generating electricity.
- Demonstration of a high temperature gradient on Saipan would increase the probability of geothermal-energy potential on Tinian, Rota, and Guam.

Consider All **Sources of Alternative Energy**

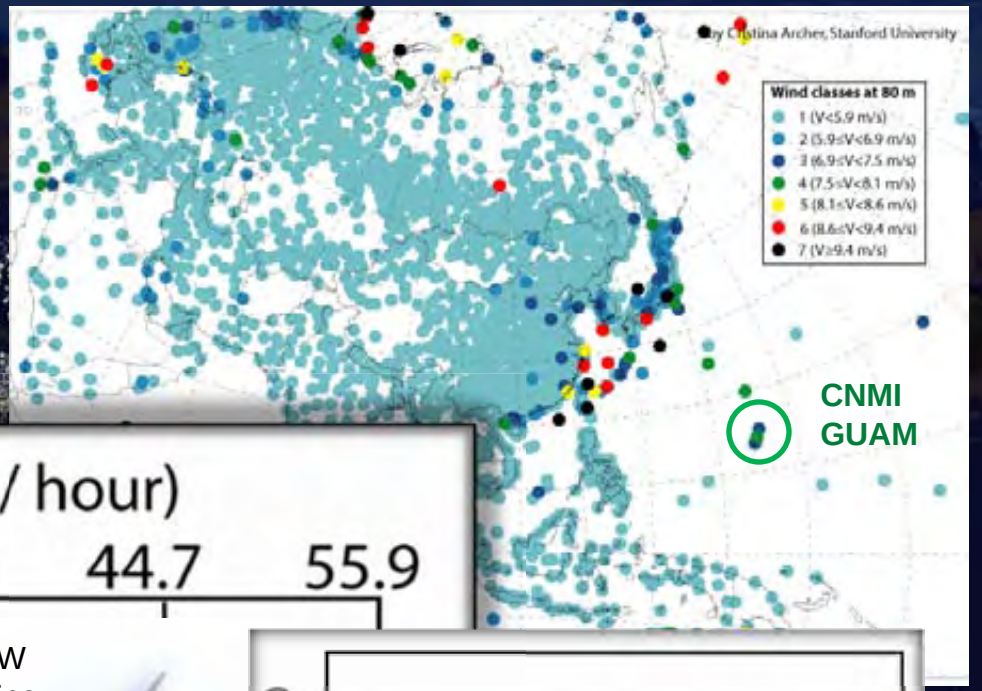
But remember that every now and then you have a really bad day.

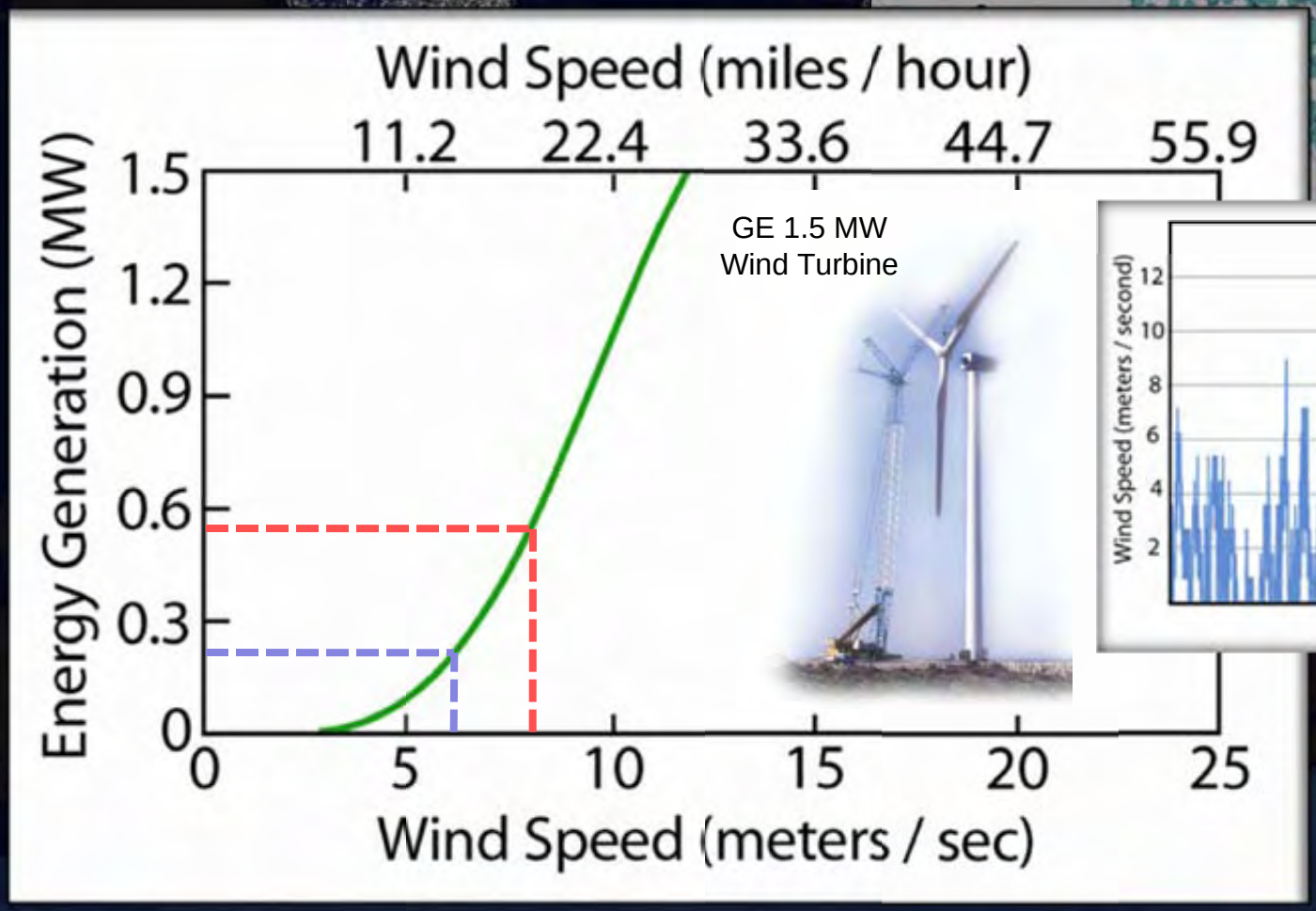




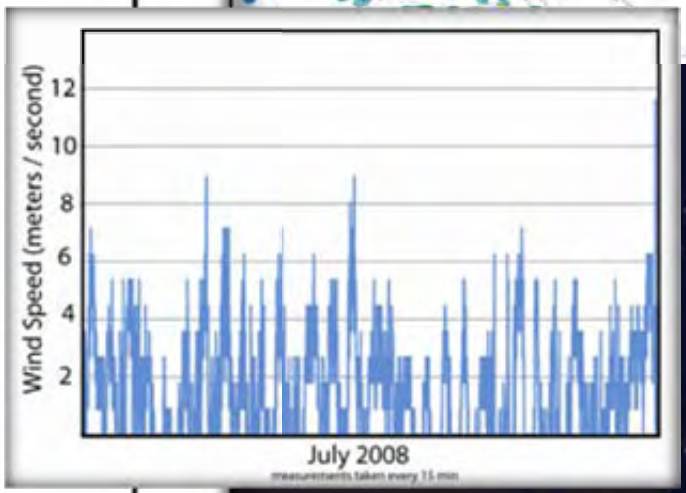
Wind Power

Analysis by Archer (2005) indicates modest potential.





GE 1.5 MW
Wind Turbine



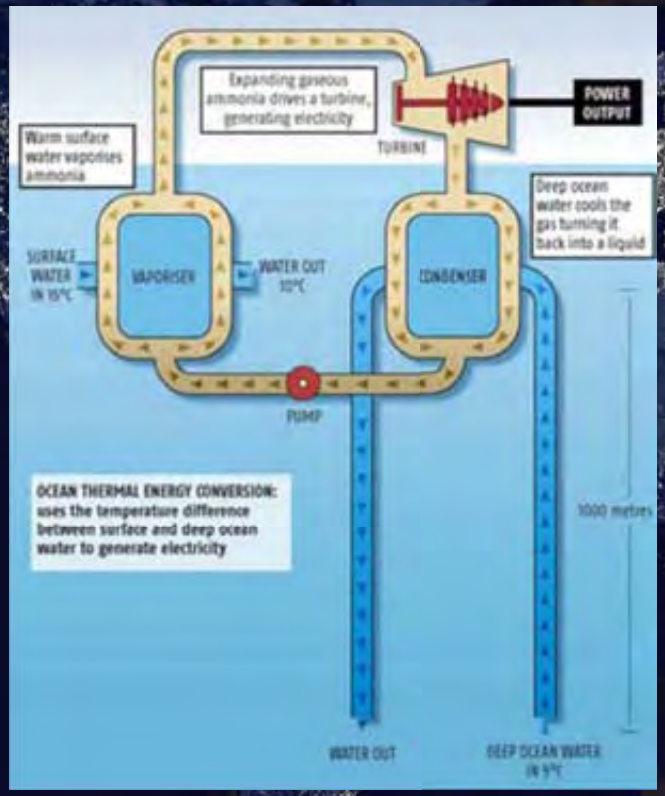
Ocean Current Power

Technical challenges need to be addressed:

- cavitations (bubble formation)
- marine growth buildup
- reliability
- corrosion

A velocity survey in the Tinian Channel is needed!

OTEC



Challenges :

- low efficiency
- marine growth buildup
- still experimental

→ **Large volumes of water must be moved!**

Plan for the long term….

but act immediately!

Micronesia will require a mix of solutions.

- **Conservation**
- **Solar Power**
- **Wind Power**
- **Geothermal Power**
- **Biofuel**
- **Power generation from solid waste.**
- **Ocean Power: currents, tides, waves, OTEC**

Sound business models based on credible scientific assessments are needed to prioritize these options and focus investment!