



Blind Geothermal System Exploration in Active Volcanic Environments; Multi-phase Geophysical and Geochemical Surveys in Overt and Subtle Volcanic Systems, Hawai'i and Maui

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Innovative Exploration Technologies

- **Timeline**

- Project start date **10/29/2009**
- Project end date **Q1 2012**
- Percent complete **~10%**

- **Budget**

- Total project funding **\$10,486,559**
- DOE share **\$4,911,330**
- Awardee share **\$5,575,230**
- FY10 funding **\$598,269**

- **Barriers**

- 'Blind' system
- Culturally sensitive location

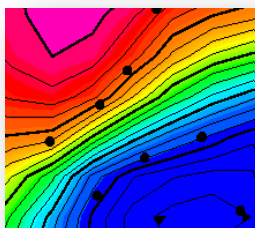
- **Partners**

- Lawrence Berkeley National Lab
- UC Santa Cruz

To fully realize the potential of geothermal in this century, we must pursue ‘non-traditional’ resource

- This project targets a ‘blind’ volcanic system on the southwest flank of Maui, Hawai’i – unconventional due to volcanic dormancy and lack of surface thermal manifestation
- Assessing unconventional targets requires re-tooling the standard geothermal exploration kit and adding in new tools

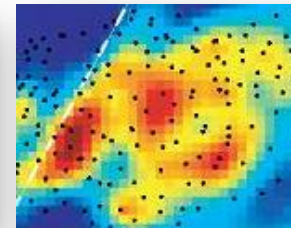
We'll combine traditional and new technologies for a fresh look at a blind system



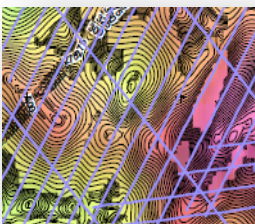
Gravity



CO₂ Flux



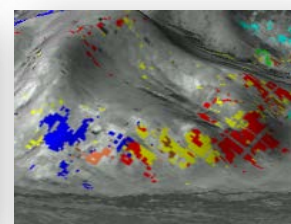
Soil Temp.



Aeromagnetics



Isotope Geochem



Hyperspectral

- We plan to use a combination of traditional geophysical and geochemical tools with exploration suites not typically used in geothermal exploration
 - These techniques will be assessed first at the Ormat-run Puna geothermal field – a ‘known’ system
 - The exploration suites will then be applied at Ulupalakua Ranch (a private lease on Maui); a site of similar, but older volcanism to Kilauea/Puna

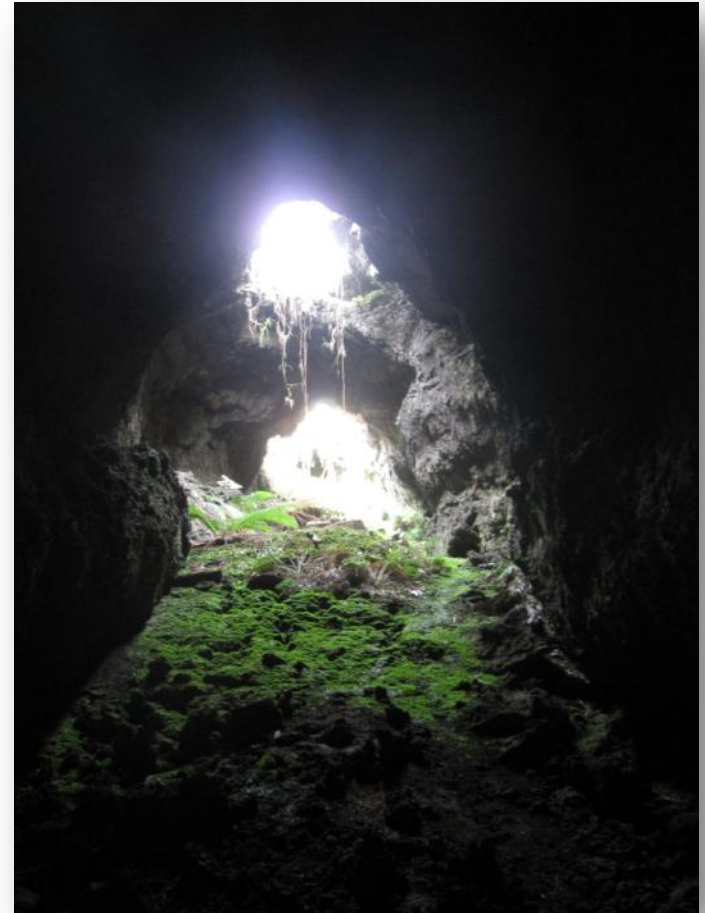


Puna, Hawai'i



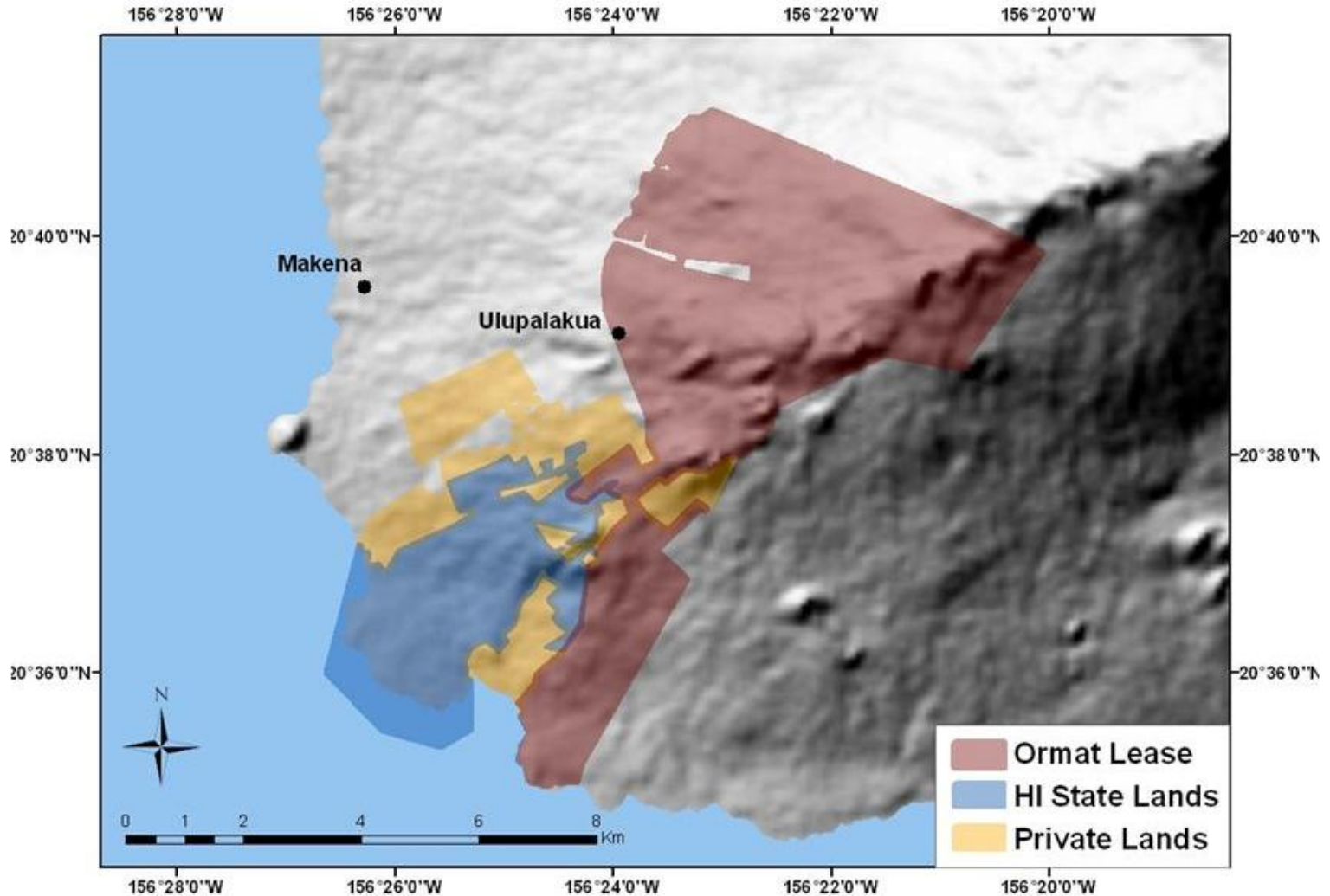
Ulupalakua, Maui

- Our research will
 - Provide a benchmark for exploration of other ‘blind’, dormant volcanic systems
 - Validate gravimetry and aeromagnetism for geothermal exploration in young, basaltic volcanic environments
 - Demonstrate use of CO₂, isotope analysis and hyperspectral imaging in young, hot-spot volcanic systems for geothermal exploration
 - Provide baseload energy for Maui island

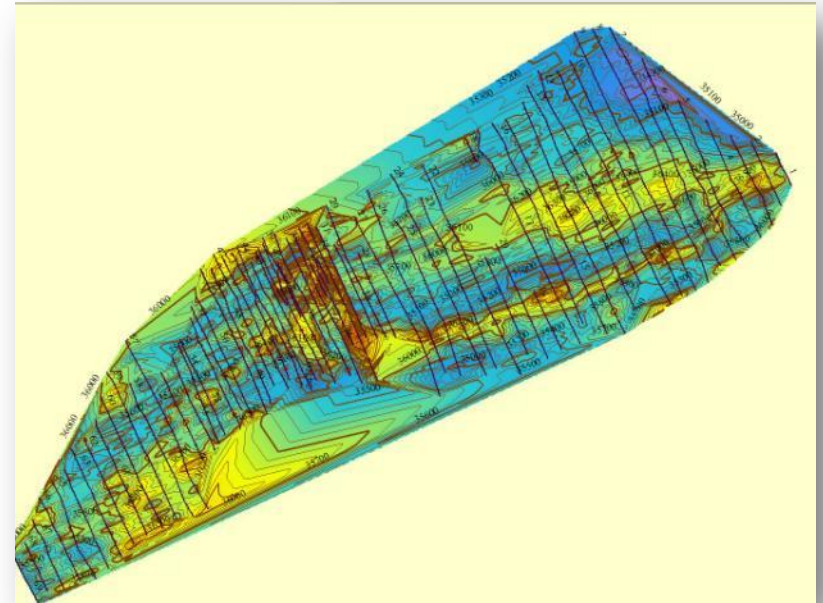


*Lava Tube (900 yrs old)
Ulupalakua, Maui*

Study Area – Ulupalakua Ranch, Maui

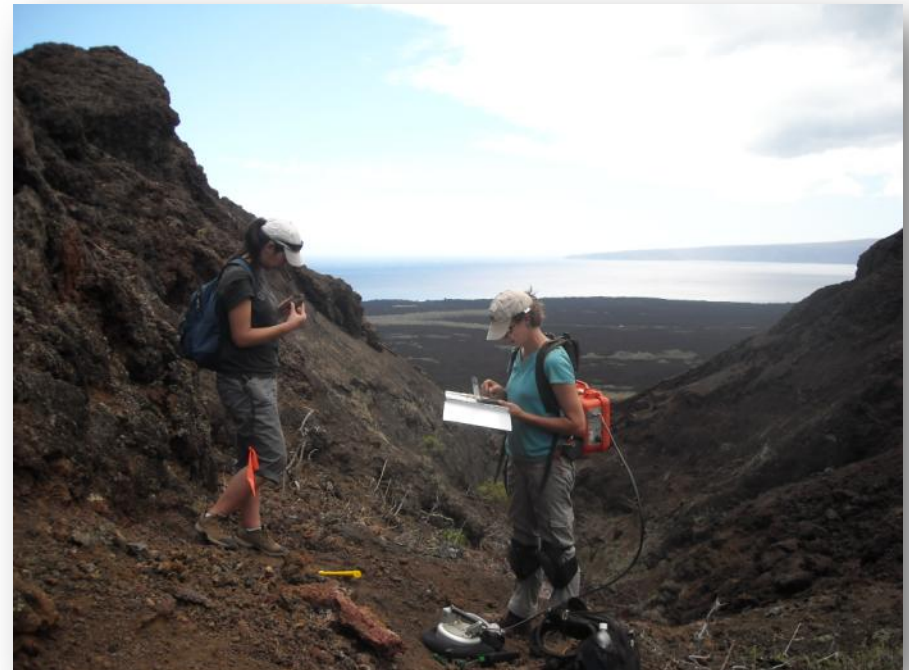


- Compile historical geophysical and geochemical information for the Puna geothermal field
 - **Status: on-going**
 - Old gravity and aeromag are being re-processed using modern algorithms and georeferenced to standard datums and projections
 - Geochemical data being compiled; many sources over three decades



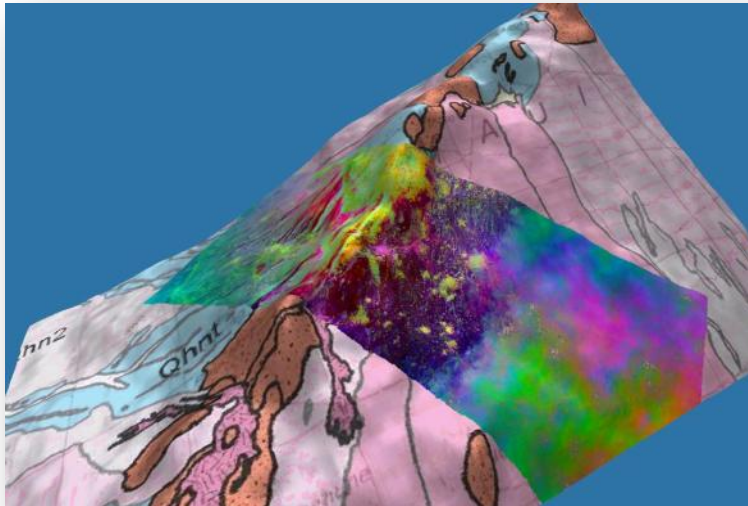
*Re-processed TMI (archival
USGS data) - Puna, Hawai'i*

- Conduct initial reconnaissance of Puna and Maui for potential CO₂ degassing (in preparation for full gridded survey)
 - **Status: completed**
 - Flux measurements were taken over three days within and directly adjacent to the Puna field during outage
 - Sites of recent volcanism along the HSWRZ were sampled over three days on Maui



*CO₂ Flux measurements
Kuala O Lapa, Maui – April 2010*

- Hyperspectral imagery analysis for biological and geological anomalies related to potential degassing or other geothermal signatures
 - **Status: In-progress.**
 - Initial analysis for vegetation stress caused by potential degassing was completed. Anomalies could not be confirmed as CO₂-induced; may be due to other factors (eg. Moisture, parasites, etc.)
 - Geological mapping on-going; alteration so-far is minimal



*Spectral analysis
for vegetation
anomalies*

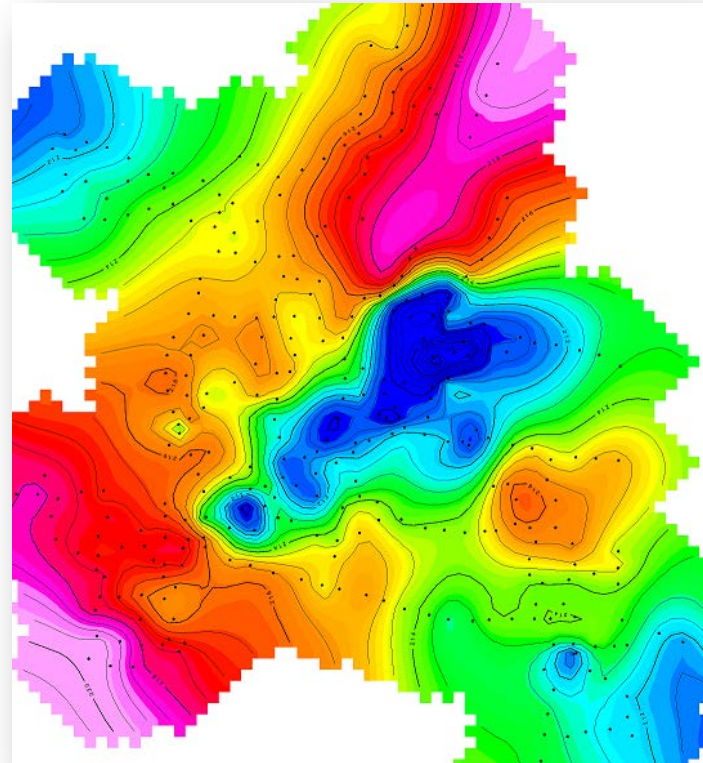
-HSWRZ, Maui

*Dead/stressed
vegetation*

*Makua Pu'u, Maui
- April 2010*

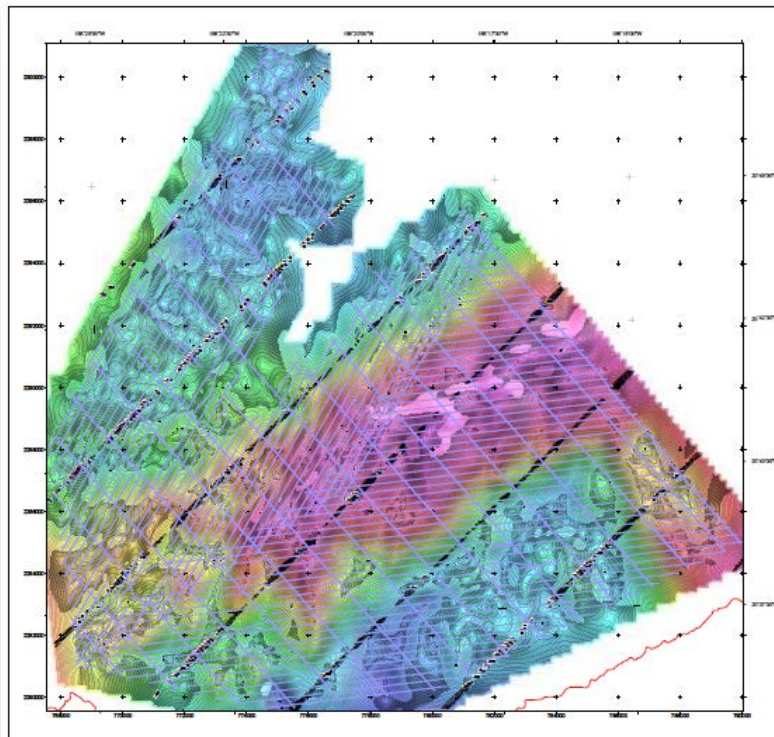


- Acquire ground-based gravity of Ulupalakua Ranch and surrounding land on Maui (~400 stations at 400 m spacing)
 - Status: 80% complete as of 3 May 2010



Preliminary Bouguer gravity (CBA@ 2.35 gm/cc). Terrain corrections range from 16m to 10km (no bathymetry, curvature, near-zone, etc. corrections yet)

- Acquire aeromagnetics of Ulupalakua Ranch and surrounding land on Maui (~1500 line kilometers @ 400 m spacing)
 - Status: Complete – post-processing underway



Preliminary RTP magnetic survey (box-grid flight lines in light purple); unlevelled in regions of high gradient - 50m grid interval

- Creation of database and 3-D structural model of the Ulupalakua project using newly acquired geophysics and ground mapping results
 - **Status: In-progress.**
 - Final delivery of Maui geophysical surveys expected in early June.
 - Re-processed Puna geophysics expected mid-June.
 - Currently testing new software suites to improve our modeling capability.
- Collection of full CO₂ flux grids and isotope geochemistry over the Puna and Ulupalakua projects as queued by the geophysical models
 - **Status: Not yet begun**
 - Planned for mid to late July

- Milestones FY2010
 - Project began 10/29/2010
 - Contract signed 4/5/2010
- Go/No-Go *Phase 1*
 - Though Maui is a site of recent volcanism, there is no surface thermal manifestation and the existence of an active, convecting hydrothermal system on Maui is presently unknown
 - Lack of faulting, fracturing and/or intrusions revealed by geophysics and field mapping coupled with no/poor geochemical results will result in a No-Go decision
 - Lack of an encouraging geochemical signature will not preclude Phase 2 drilling

- Project Management

- Martini (co-PI) is managing and overseeing all phases of database creation, geophysical acquisition, hyperspectral analysis, project logistics and budgeting
- Lewicki (co-PI) is coordinating the geochemical surveys (CO2 flux and isotope)

- Schedule

- Phase 1 completion **(Q4/2010)**
- Phase 2/3 completion – Permitting and drilling **(Q4/2011)**

- NGDS integration

- Our database (that will include geophysical surveys and geochemical measurements) will be provided to the NGDS in whatever requested format is decided upon



*Southwest Rift Zone
Makua Pu'u, Maui – April 2010*

- We're looking towards development of our structural model to queue geochemistry this summer 2010
 - *We expect to site drill targets in Q4/2010*
- Community outreach continues
 - *Renewable energy has a lot of support in Maui (~9% of their load is wind)*
 - *Our private lease with Ulupalakua Ranch remains solid and adjacent landowners are supportive*
 - *Traditional resources have been identified and the Native Hawaiian community remains supportive*
 - *The Natural Area Reserve System has been engaged and has also been supportive to our exploration*

- Key geophysical surveys are complete or near completion on Maui
- Historical databases for Puna are in-progress
- The second half of Phase 1 (geochemistry) will begin in July 2010
- A Go/No-Go decision will be made in Q4 – 2010 with regards to drilling

