The Humuʻula Groundwater Hydrology Investigation

- Summary of Drilling
- Well Testing Results
- Next Steps

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Resistivities encountered along the saddle road in the relatively dry volcanic terrain. Plot is looking north with west to the left and east to the right.
Based on the positive indications of high level water, decision was made to proceed with a test well

Objectives of the drilling effort were:
- Determine depth to groundwater within mid-Saddle region
- Determine water quality
- Develop a better understanding of regional hydrology
Drilling was initiated in March, 2013 at an elevation of 6375’ (1943 m) and was completed at ~5786’ (1763 m) depth in late June.

Drilling Program

- Small diameter hole
- Continuous coring to recover rock properties
- Determine depth to water
- Collect fluid samples
Hydrology Findings

- Shallow section is dry to ~700'.
- Formation was saturated from that depth to the total depth of the hole.
- This appears to be the regional aquifer of the Mauna Kea Saddle.
- Perched aquifer at ~700' to ~1200'.
- "Final" saturated zone at ~1800'.
- Unsaturated layers below 1200'.

Depth versus Time

Date


Drilling depth versus time

- Stable fluid level in hole ~700' to ~1200'.
- Stable fluid level encountered at 1800'.
- Saturated Formation.
Thermal conditions are different from expected.

- Shallow section is about local ambient.
- Below 2000' depth we begin to see temperature increase.
- Increase in temperature steepens as we get below 3000'.
- Suspended drilling when temperature reached 100 °C.

Equilibrium temperature is ~140 °C.
The deep regional aquifer may be a dike-impounded groundwater system that extends through the Saddle region. Working Model Subsurface resistivity data indicate high level water may extend across the entire Saddle region. Recent gravity modeling has shown evidence of a broad intrusive complex through the center of the island.
Collect fluid samples for detailed chemical analysis

Install a small diameter (<4") pump capable of lifting water 1800' to surface

Pump Test

Perforate casing 2000' to 2200' depth

Install packer below perforations

Pump well at 10, 20, 30, 40 gpm while monitoring drawdown of water table and recovery after pumping

Perforate casing @ ~200' below water table

Install Packer below perforations
Pump Draw-Down Results are encouraging

- Well was pumped at variable rates for a total of ~36 hours producing ~42,000 gallons of water.
- Draw-down of water table was modest—amounting to ~11” of water and complete recovery in ~2 hours.

Second Pumping Interval

10 second sample interval

Rotation started @07:29
Flow increased to 20 gpm
Flow decreased to 20 gpm @ 12:14
Flow resumes @ 22 gpm @ 15:25
Flow at 19 - 22 gpm 15:25 to 07:15
Flow suspended @07:15 to service top drive and surface pump
Rotation terminated @13:25

Discharge at surface @07:57
Flow at ~12 gpm
Flow increased to 30 gpm @ 11:09
Flow suspended to service engine
Flow resumes @ 22 gpm @ 09:50

Flow resumed @ 22 gpm @ 09:50
## Chemical Analysis Results

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<th>Sodium</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Chloride</th>
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<td>8.8</td>
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</table>

pH of the water is unusual ~8.4

No “hits” on SDW contaminant screen

Age of the water was greater than we were expecting – averaging ~ 9500 years
Summary Findings

• The resource at 700’ appears to be substantial but not as large as the 1800’ aquifer
• The water quality is expected to be very good as it is not affected by underlying geothermal activity
• The age of the water is likely to be considerably younger
• We will need to conduct a second pump test to verify production characteristics
Remaining Major Project Objective

Define the western extent of the aquifer with a second test hole.
Drilling Not Yet Complete
Preliminary Findings

- Sequence of perched and/or confined aquifers beginning at 1000’ BGS

- Confined aquifers present progressively higher hydrostatic heads

- Confining formations are mostly soil and ash intervals

- May have just missed the western edge of Saddle dike impounded aquifer – fewer dikes deeper & lower T
Next Steps

- Conduct water sampling to determine isotopic and chem compositions
- Conduct geophysical logging in the test holes
- Analysis of the stratigraphic “structure” of the core from 2nd hole to get a better understanding of their source and extent
- Determine ages of the water
http://www.higp.hawaii.edu/hggrc/projects/
Recommendation

- Conduct testing of 700’ aquifer
- Based on production characteristics and chemistry proceed to production well at 1000’ or 2000’ adjacent to PTA-1
- Complete PTA-1 as a monitoring well for the aquifer developed
Conduct additional MT and gravity surveys over the PTA footprint and over the DHHL lands to the east. Extend MT and gravity surveys over to the Waimea region. Ongoing work to characterize the geothermal potential.
Completed the field surveys for the MT soundings on the PTA parcels. Conductivity profiles indicate that there may be significant thermal areas within the Saddle region. Preliminary analysis of the resistivity has been completed.
Implications of Findings

Substantially larger volumes of water are stored inside the island. New dike complexes imply alternative sources of stored heat: geothermal. Geophysical surveys are now underway to define the conductive regions on MK, between MK and Kohala, and on Hualalai.