Geothermal Resource Assessment for Grenada, West Indies
for Grenada Electricity Services Ltd. (Grenlec)
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GEOTHERMAL RESOURCE ASSESSMENT FOR GRENADA, WEST INDIES

SUMMARY

The distribution of thermal features, primarily warm springs, indicates that Mt. St. Catherine hosts a low to moderate temperature geothermal reservoir. Despite age dates of about 1 million years for the most recent volcanic products, Mt. St. Catherine still provides a viable heat source for the system.
The geothermal system appears to be centered beneath the upper slopes of Mt. St. Catherine with outflow north and northeast towards the chloride warm springs at Castle Hill and Chambord. Temperature estimates from chemical geothermometry suggest a reservoir temperature of 350- 400 :F, and potentially higher. The majority of thermal features, including the chloride springs, appear to lie on the periphery of the geothermal reservoir. Despite high salinities, the warm springs at Castle Hill and Chambord, have low temperatures, generally less than 110 :F, indicating substantial conductive cooling along their flow paths.

Geologic traverses found ample of evidence of fractured rocks, and, when combined with the large amount of leakage from the system, indicates that reservoir permeability should be good. The reservoir may be partially hosted by sedimentary rocks, which could lower overall permeability and possibly increase the risk of calcite deposition in wellbores. Additionally, the caprock overlying the system may be relatively permeable, raising the risk of cold water influx should reservoir pressures be drawn down during exploitation.

Reservoir chemistry issues are likely to be low. The warm spring chemistry indicates that the system hosts a neutral pH fluid. While there is potential for calcite scaling in the wellbores during production, as suggested by the travertine deposits associated with some of the warm springs, the scaling could be mitigated by preventing boiling in the wellbore or through downhole chemical mitigation.
The highest resource risks are reservoir temperature and volume. The volume of high temperature fluids may be quite small, deep, and difficult to locate through exploration drilling. Additionally, the topography, combined with temperature, may be a significant issue for well productivity. Wells drilled at high elevation locations may be unable to produce due to a combination of low reservoir temperature and pressure. This would favor drilling wells from lower elevation locations directionally towards the peak of Mt. St. Catherine. However, such wells may have difficulty encountering adequate reservoir temperatures for commercial production. Nevertheless, should the exploration wells encounter commercial reservoir temperatures, there should be sufficient resource volume to support a 30 MW project.

RECOMMENDATIONS

To further evaluate the development potential of the geothermal resource at Mt. St. Catherine, the following recommendations are offered.

Acquire a Contract Area. Mt. St. Catherine hosts a single geothermal system. Therefore, the contract area should cover the entire prospective area, including all thermal manifestations that can be related to Mt. St. Catherine.

Wellbore Modeling. Because of the potential for drilling high elevation wells into a moderate temperature, under pressured resource with a liquid level near 1000 ft. elevation, wellbore modeling is recommended. This modeling should help with the selection of exploration drilling locations and well targets. The following issues should be addressed through the wellbore modeling:

- Influence of elevation on well productivity, especially the role of boiling in providing steam lift to the produced fluids.
- The placement of pumps in the wellbore to aid production under low reservoir temperature conditions.

Geologic mapping. A good geologic map should be developed for the prospective area. This map should show major geologic units, volcanic structures, and faults. The mapping should help establish the potential reservoir rocks and structural targets for the exploration wells. To assist the geologic mapping, remote sensing images and either LIDAR images or aerial photography of the contract area should be obtained. The aerial photography, LIDAR, or overlapping remote sensing images should be used to develop a Digital Elevation Model for the contract area. This model will assist the geologists and geophysicists by ensuring that they can accurately locate themselves in the field and should also help project engineers with the selection and design of roads and locations. Adequate regional geologic maps and air photos may already be available from an agency on Grenada. If not, then the area should be flown so that new aerial photography or LIDAR can be obtained.

Geophysical Surveys. A very important next step for the exploration of the resource is a geophysical survey to measure the resistivity of the earth in the prospective area. This survey should involve both magneto-telluric (MT) and Time-Domain Electromagnetic (TDEM) stations. This survey should help resolve the distribution of the low resistivity clay caprock overlying the geothermal system. The shape and distribution of the low resistivity layer should be integrated into alternative conceptual models of the reservoir in order to identify the highest potential exploration drilling targets. Gravity and magnetic surveys are not recommended for this prospect.

Exploration Well Planning. Three exploration wells are recommended to be drilled at Mt. St. Catherine. These wells should incorporate a slimhole well design that will allow the wells to be flow tested. The wells should be targeted to 6000 ft. total depth and should be drilled directionally towards the upper slopes of Mt. St. Catherine. Without the geophysical results, siting of drilling locations is difficult. The current thought is to build a total of four drilling locations, with two locations each on the west and east slopes of the volcano. The three wells should be drilled sequentially. Once a well achieves drilling success, it should be followed up by a second exploration well from a nearby location to confirm the extent of the resource. Two successful slim holes should be adequate to demonstrate the feasibility of a 30 MW project.

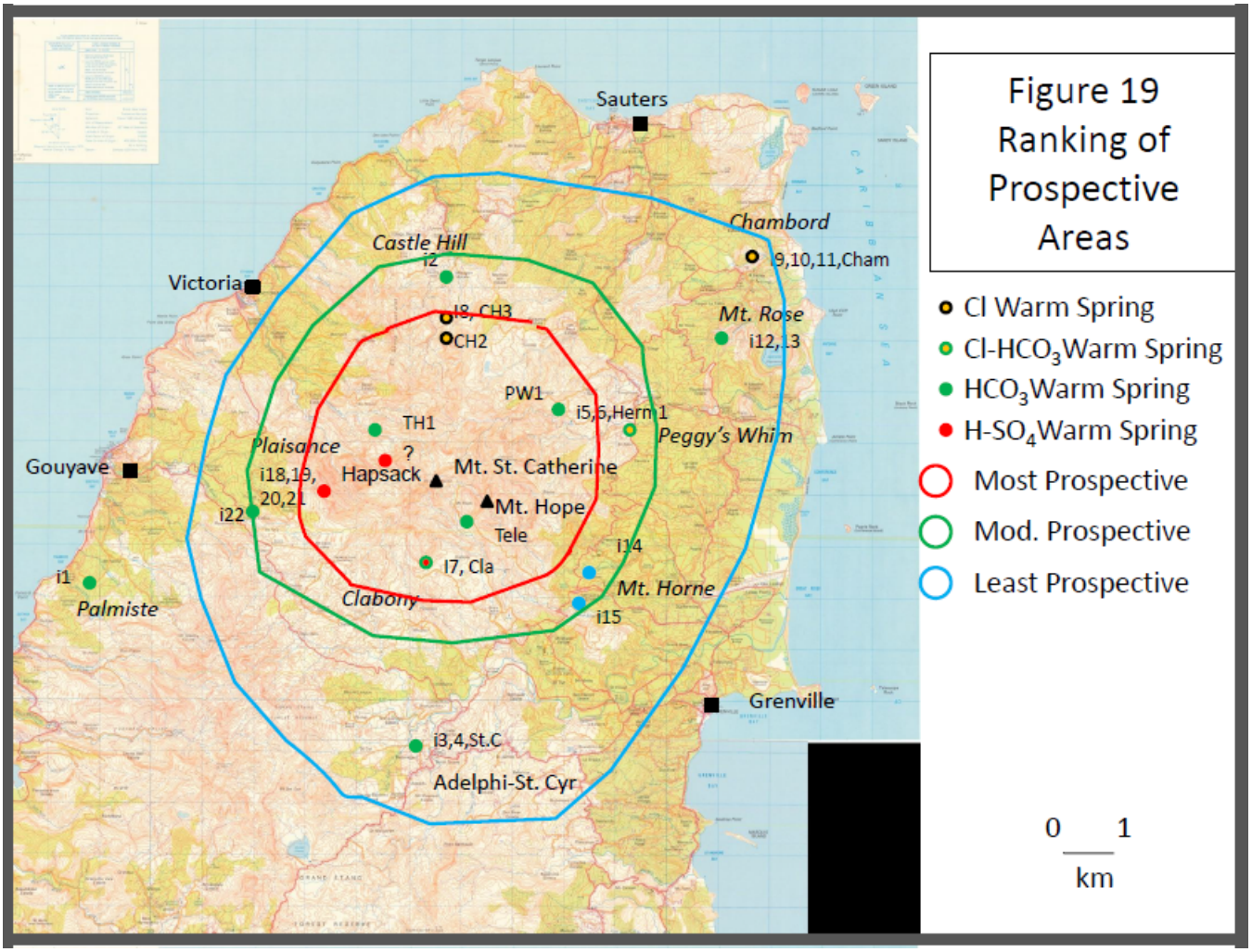
Figure 19
Ranking of
Prospective
Areas
Cl Warm Spring
Cl-HCO3 Warm Spring
HCO3 Warm Spring
H-SO4 Warm Spring
Most Prospective
Mod. Prospective
Least Prospective
0 1
km
Sauters
Chambord
9,10,11,Cham
Castle Hill
i2
Victoria
I8, CH3
CH2
Mt. Rose
i12, 13
PW1
i5,6,Hern 1
Peggy's Whim
TH1
Plaisance
?
Hapsack
Mt. St. Catherine
Gouyave
i18,19,
20,21
i22
Mt. Hope
Tele
i14
i1
I7, Cla
Mt. Horne
Palmiste
Clabony
i15
Grenville
i3,4,St.C
Adelphi-St. Cyr