

Energy for Sustainable Development in the Caribbean

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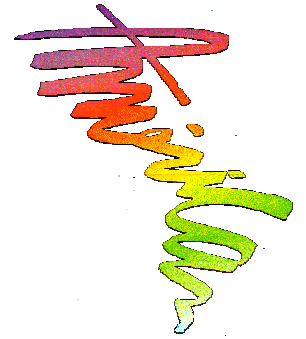


Power Generation in the Caribbean

| Country | Thermal | Hydro | TOTAL |
|--------------------------------|---------|-------|-------|
| Antigua and Barbuda | 51 | 0 | 51 |
| Barbados | 210 | 0 | 210 |
| Cuba | 3,901 | 57 | 3959 |
| Dominica | 14 | 8 | 22 |
| Dominican Republic | 4,184 | 542 | 4726 |
| Grenada | 32 | 0 | 32 |
| Haiti | 181 | 63 | 244 |
| Jamaica* | 1,325 | 24 | 1349 |
| Saint Lucia | 57 | 0 | 57 |
| Saint Kitts & Nevis | 47 | | 47 |
| St. Vincent and the Grenadines | 18 | 6 | 24 |
| Trinidad and Tobago | 1,416 | 0 | 1416 |

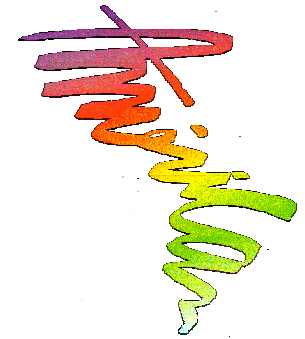
Source: Energy Information Administration (EIA), 2004

*Wind: Jamaica accounts for 20 MW.



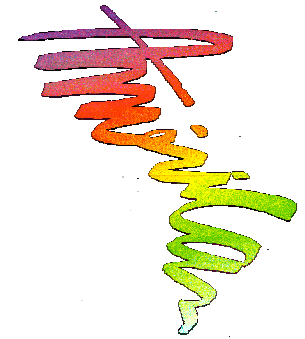
Electricity Sector Organizational Arrangements

- Vertical Monopolies Dominate:
 - Generally operate with long-term agreement, with fixed percentage ROI
 - Limited options for IPPs
 - Small systems create big challenges for competition
 - Private: LUCELEC, GRENLEC, DOMLEC
 - Public: St. Kitts Electricity Dept., NEVLEC, APUA, MONLEC, VINLEC, BL&P



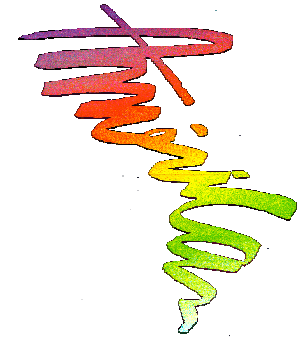
Recent Energy Sector Trends/Developments in the Eastern Caribbean

- Push to open electricity markets to competition
- Accept oil discounting arrangements (i.e. PetroCaribe)
- Establish policies, plans, strategies, laws, etc. that favor sustainable energy
- Promote the development and use of biofuels and bio-electricity
- Promote the development and use of other renewable energy alternatives



On-Going Sustainable Energy Programs/Initiatives in the Region

- Regional Initiatives:
 - Caribbean Renewable Energy Development Programme (CREDP) [CARICOM, GTZ, UNEP/GEF]
 - Global Sustainable Energy Islands Initiative (GSEII) [OAS, The Climate Institute, ESG, UNIDO]
 - Proposed establishment of Caribbean Renewable Energy, Energy Efficiency, and Bioenergy Action Program (CREBAP) [OAS, IICA, IADB, CARICOM, Countries]
 - Proposed development of CARICOM Regional Energy Policy
 - US-Brazil Biofuels Partnership [Dominican Republic, Haiti, St. Kitts and Nevis, El Salvador]

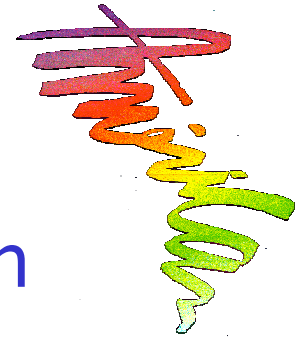


On-Going Sustainable Energy Programs/Initiatives in the Region

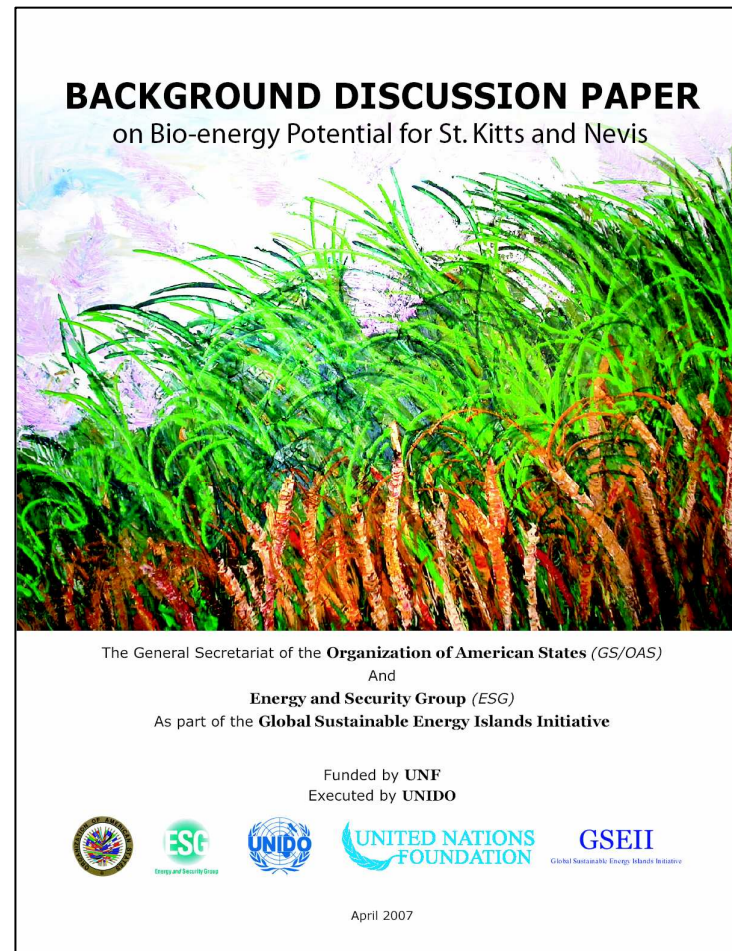
- Preparing launch of the **Caribbean-EUEI Sustainable Energy Assistance Programme**
 - Funding from the European Commission (EUEI)
 - Implementation by the OAS with CARILEC, and CARICOM
 - Project Countries: The Bahamas, St. Vincent and the Grenadines, Antigua and Barbuda, St. Lucia, Dominica, St. Kitts & Nevis, Grenada
 - Key Goals:
 - Develop institutional and human capacity
 - Prepare plans, policies, regulations, laws, ... for sustainable energy
 - Identify and assess project opportunities
 - Establish regional and national sustainable energy support offices



National Sustainable Energy Programs/Initiatives in the Region



- **St. Kitts & Nevis Bio-Energy Feasibility and Development Program**
 - SKN sugar industry closed in 2005
 - OAS/GSEII team assessing biomass to energy alternatives (sugar and municipal waste)
 - Options may include ethanol, electricity, other byproducts
 - On-going analysis including TA from Dr. Al Binger, and soil/crop analysis by the Fundacao Getulio Vargas (FGV)
- SKN included in **USA-Brazil Biofuels Bilateral Agreement**

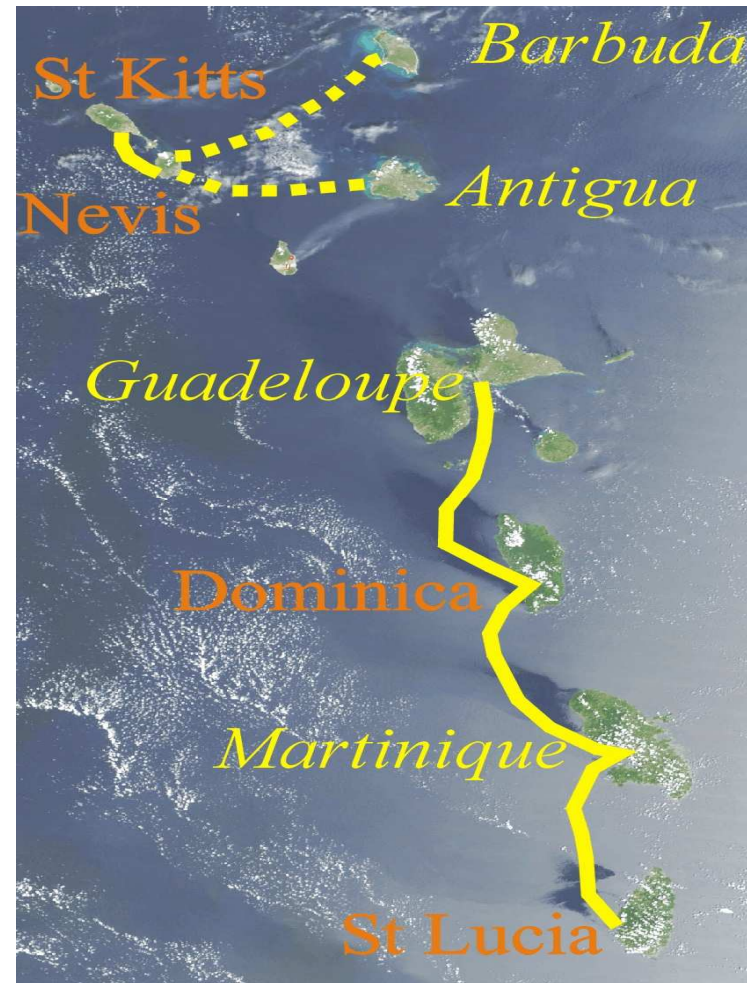




On-Going Sustainable Energy Programs/Initiatives in the Region



- Eastern Caribbean Geothermal Development Project (Geo-Caraïbes) – GEF+ Funded
 - St. Lucia, St. Kitts & Nevis, Dominica
 - Partners: OAS, AfD/FFEM, UNEP
 - PDF-B Project Components:
 - Resource Exploration (Surface Studies)
 - Policy Preparation (Regional and National)
 - Design Drilling Risk/Feasibility Financing Tool
 - Catalyze multiple commercial geothermal projects and inter-island electricity transmission





Geo-Caraïbes PDF-B Findings and Next Steps: St. Lucia



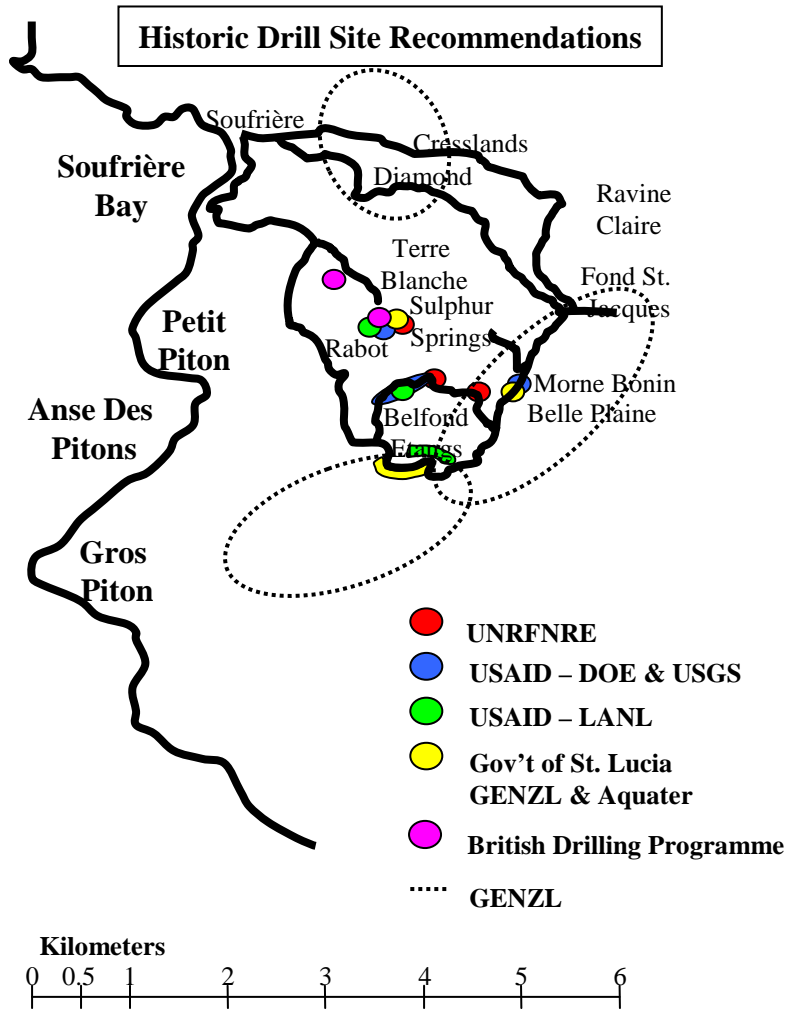
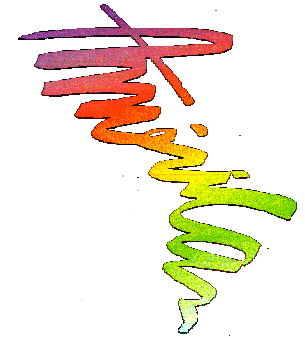
Background/History

- Serious geothermal resource exploration began in the mid-70s by the British Geological Survey
- After dozens of investigations and nine drilled holes, no real geothermal development has resulted to date





Geo-Caraïbes PDF-B Findings and Next Steps: St. Lucia



Time Line

| | |
|-----------|--|
| 1951 | British start formal investigation (Willmore) |
| 1964 | Tomblin performs detailed geology survey |
| 1974 | Institute of Geological Sciences (IGS) U.K. resistivity survey |
| 1975-76 | Seven wells drilled by IGS (Wells 1-7) |
| 1976 | Aspinall et al. perform seismic monitoring |
| 1982 | Aquater (Italy): Magnetotellurics, gravity, well data evaluation. |
| 1983-84 | Los Alamos (USA): Geology, geochemistry, geophysics |
| 1987-88 | USAID/UN: Drill two deep wells (SL1 & SL2) |
| 1992 | Geothermal Energy New Zealand: Gravity, resistivity, audio magnetotelluric resistivity |
| 1998-2006 | M.I.T.: Reinterpretation of British resistivity data, self potential geophysics, decision analysis |



Geo-Caraïbes PDF-B Findings and Next Steps: St. Lucia

- **Synopsis of Four MIT Studies**
 - Reinterpretation of the British Line 9 resistivity data
 - 3D rendering of 2D resistivity inversions
 - Self Potential surveying
 - Geological/Geophysical data integration using a decision analysis method
- **Eleven datasets were used:** Seismics, self potentials, fault structure, deep resistivity, shallow resistivity, geology, topography, wells/springs/geochemistry, shallow AMT, deep AMT, and residual gravity

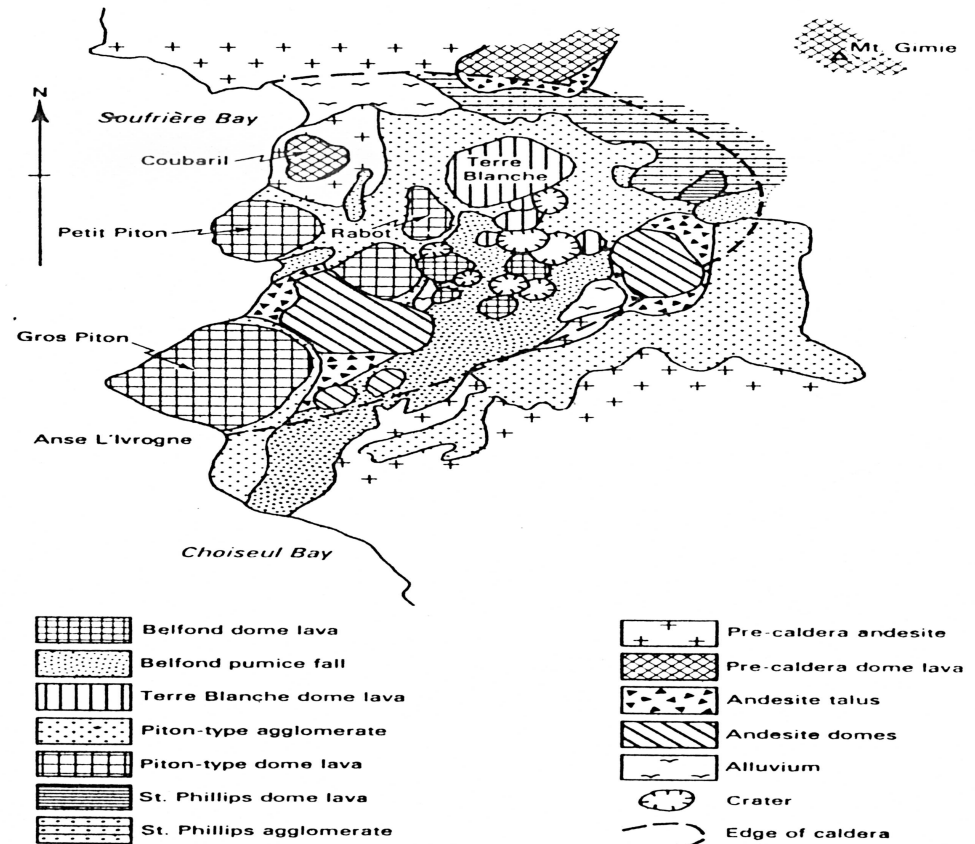
Geo-Caraïbes PDF-B Findings and Next Steps: St. Lucia



Summary/Conclusions

- Good geothermal development potential, but...
- Very complex geology and hydrogeology
- The chemistry of the geothermal waters beneath the Sulphur Springs is quite severe
- The geothermal reservoir cap rocks are weak
- Exploration may be best optimized by exploring for less hot – but less corrosive – waters away from the Sulphur Springs
- Challenge created by designation of World Heritage Site
- Private company holds MOU (from 2004) for exploration/development, but minimal activity

Geology



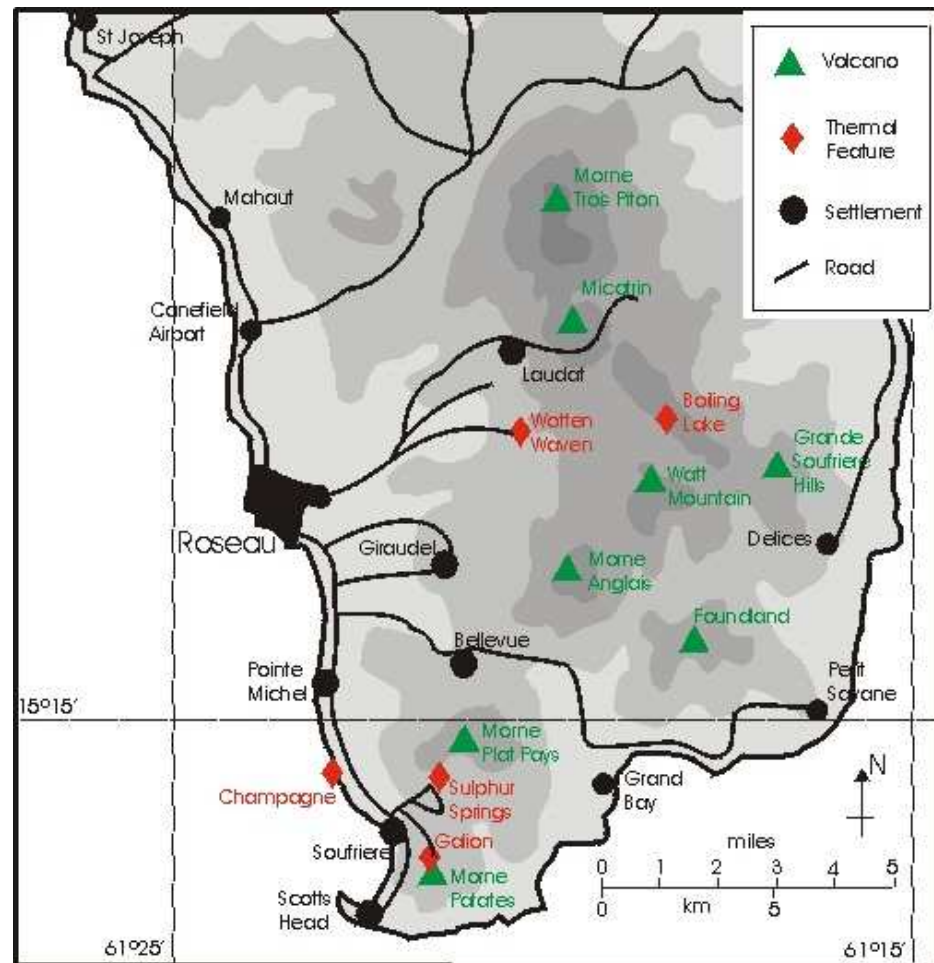


Geo-Caraïbes PDF-B Findings and Next Steps: Dominica



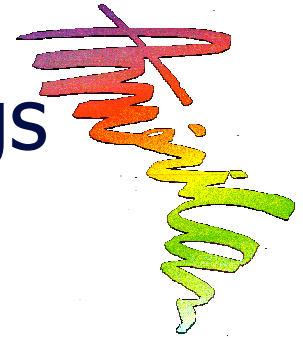
Geo-Caraïbes Activities

- BRGM/CFG work concentrated on geochemistry and structural geology
- Geochemistry used to characterize the resource at depth, especially in terms of temperature of resource and hydrothermal regime
- Structural geology (also GeoSy and G. Hutterer) important in identifying subsurface porosity/permeability characteristics and ultimately in helping to find the best subsurface flow rates



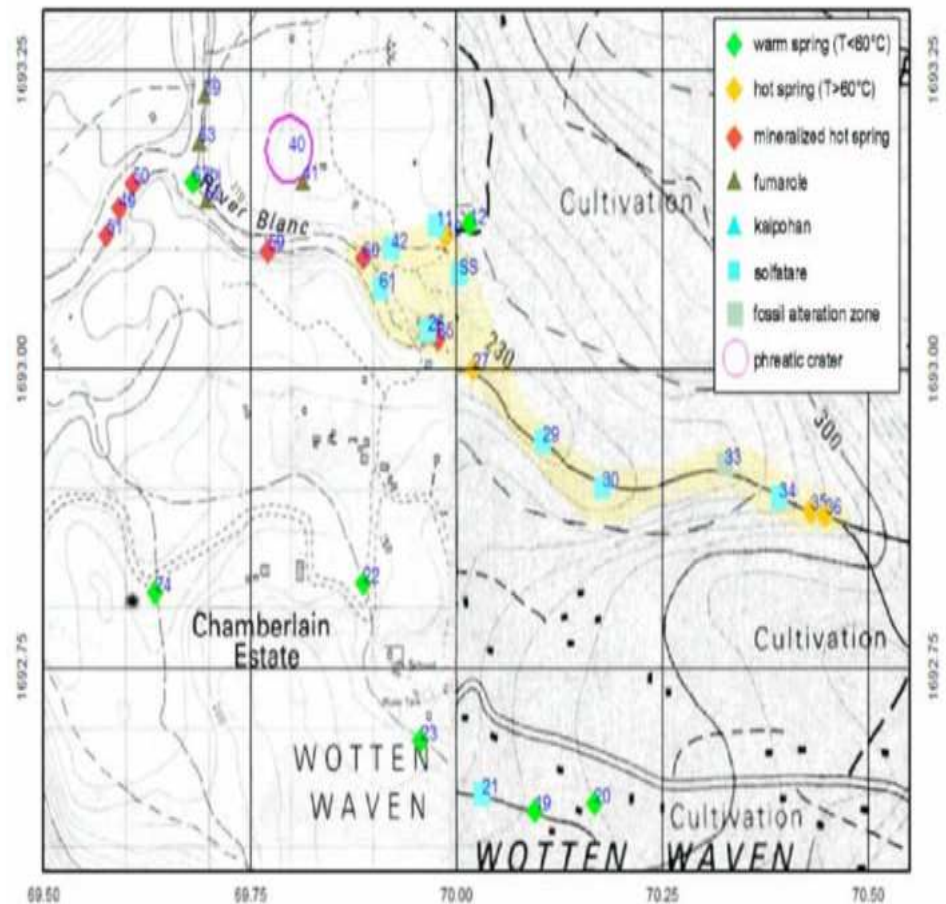


Geo-Caraïbes PDF-B Findings and Next Steps: Dominica



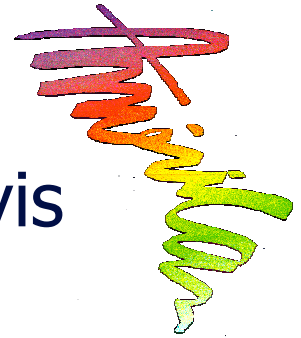
Current Status

- AfD/FFEM currently supporting expanded geophysics and geochemistry – setting up for exploratory drilling
- EUEI funding feasibility study focused on potential for interconnection with French Islands
- Multiple private sector companies have approached the Government of Dominica with proposals for development





Geo-Caraïbes PDF-B Findings and Next Steps: St. Kitts & Nevis



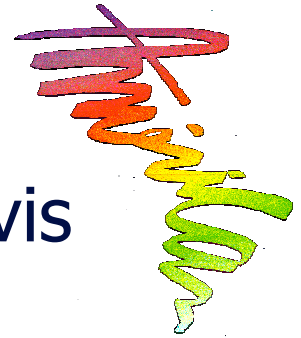
Background/History

- The islands are two of eleven Caribbean islands of volcanic origin
- The dome within Mt. Nevis is ~ 60,000 years old
- Earthquakes are common, with a notable swarm in 1950-1951
- Dominant regional fault orientations are NE-SW and NW-SE
- No geothermal wells drilled until current exercise



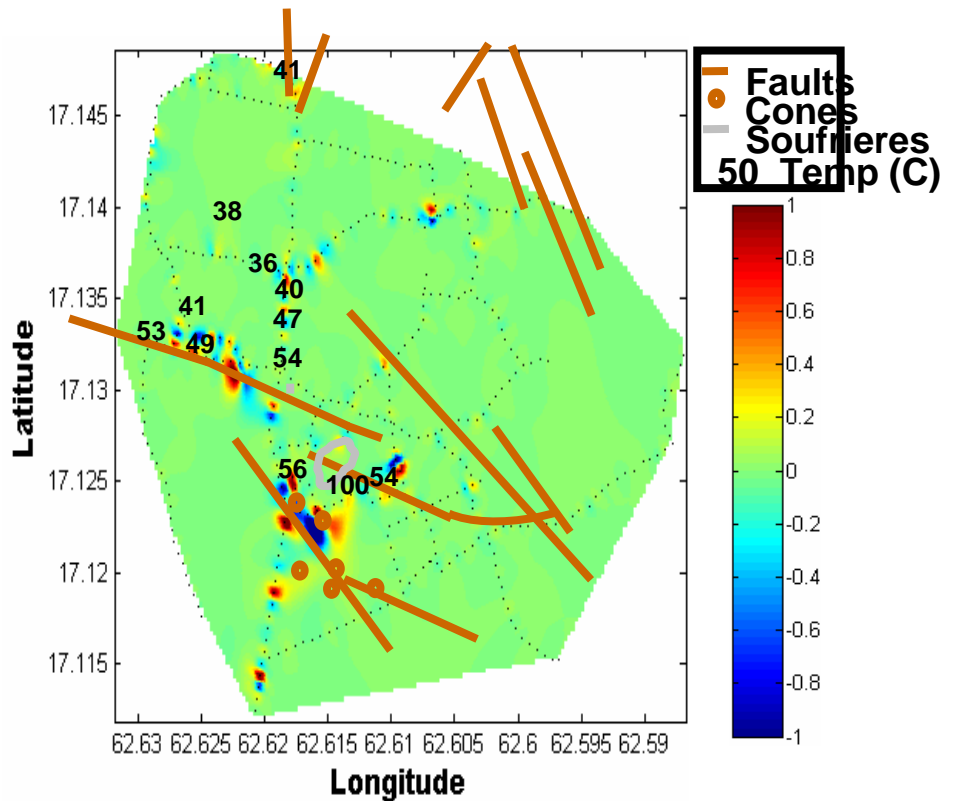


Geo-Caraïbes PDF-B Findings and Next Steps: St. Kitts & Nevis

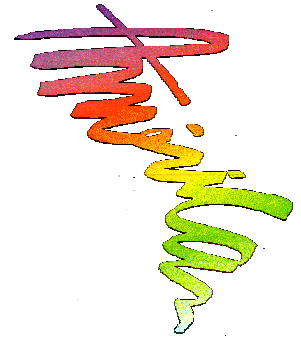


Geo-Caraïbes PDF-B Activities

- Geological reconnaissance mapping of western Nevis
- Geochemical sampling and evaluations of thermal waters, on and offshore, with emphasis on the western side of Nevis
- Gravity and geographic positioning surveys in the SW part of the island
- A Self-Potential ("SP") survey in the SW part of the island
- Geo-Sciences by: GeoSy, G. Hutterer, GeothermEx, MIT, SP International, University of the West Indies – SRU



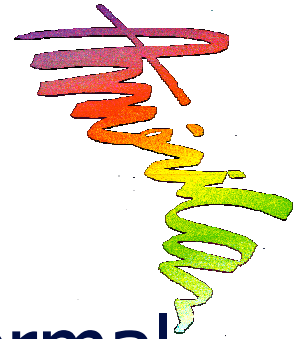
Normalized SP Current Sources (MIT/SP). Faults and Cones from Hutterer (1998) and Temperatures from GeothermEx (2004).



Geo-Caraïbes PDF-B Findings and Next Steps: St. Kitts & Nevis

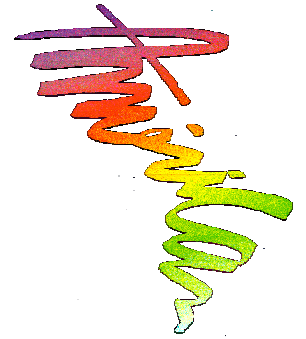
- Current Status

- Recent MOU/Contract between Nevis Island Administration (NIA) and West Indies Power for Exploration and Development
- Additional Geo-Physics, Geo-Chemistry and Geology Completed
- Exploratory well drilling currently underway
- OAS legal team advising Federation and NIA on contracts, PPA, geothermal policy
- Plan to develop geothermal power for use in Nevis, St. Kitts, and export to neighboring islands



New Opportunities to Further Geothermal Development in the Caribbean

- Expansion of “mature” opportunities: Those countries with considerable exploration and research completed: Dominica, St. Kitts & Nevis, St. Lucia, Guadeloupe, Martinique, Montserrat
- Launch of early-stage investigation: St. Vincent & the Grenadines, Grenada, Saba, St. Eustatius
- Partner with regional institutions involved with Energy/Geothermal Development: OAS, CCCCC, UWI, CARILEC...



Thank you!

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