Background

The DARPA program manager who supports the PowerBuoy project has been interested for some time in exploring options to generate power from hydrothermal vents. This summer (2010) she supported the installation of a heat flux measuring probe (figure 1) in a hydrothermal vent at Axial Seamount (UofW/APL). This device was a thermally conductive rod with sufficient electronics to measure the temperature along the rod. The idea is that this device can be calibrated to relate heat flux to measured temperature gradient. The device was installed for approximately one month and has recently been recovered, data analysis is pending. A second similar device with a one year logging capability was installed when the first was removed.

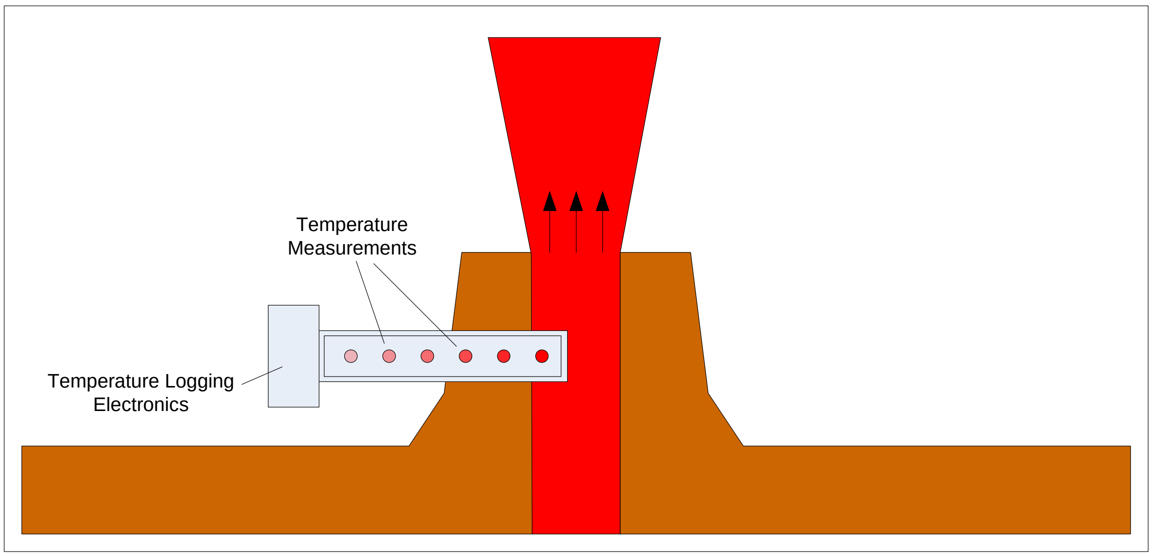

Figure 1: Schematic of heat transfer probe installed for one month in the summer of 2010. Temperature measurements were made along a conductive rod. The device has been recovered and data analysis is pending.

Suggested next step
For the purposes of evaluating how much heat energy can be extracted by this approach, the experiment described above is limited in several ways; the maximum heat transfer through the device is limited by the ability for the cold end to reject heat and there is no ability to vary or control the amount of heat being extracted from the vent. This second is important because there is wide speculation that if one extracts too much heat, the cooling of the vent fluid will cause precipitation around the heat probe that will eventually insulate it from the hot fluids.

Predicated on data from the first experiment that shows a persistent temperature gradient across the heat probe, a logical next experimental step to take would be to install a device that allows a larger, controllable amount of heat to be extracted from the fluid with the aim of characterizing the possibilities and exploring the limit based on precipitation effects. Figure 2 illustrates an experiment that could address these issues. The inclusion of a working fluid and heat exchangers seems sensible as both a heat transfer test and also as a prototype for an actual energy extraction system. This approach provides the possibility to significantly separate the hot and cold sides of the system which could provide some flexibility in the location of the vent fluid and would possibly allow more than one vent to contribute. The conversion of heat energy to electrical energy would not need to be addressed in this experiment since that component is more well understood than the vent fluid and thermal dynamics. The existence of a hot working fluid at a distance from the vent could potentially used for non electrical purposes such as heating scientific experiments through the use of a thermostatically controlled valve that would shut hot water as needed.

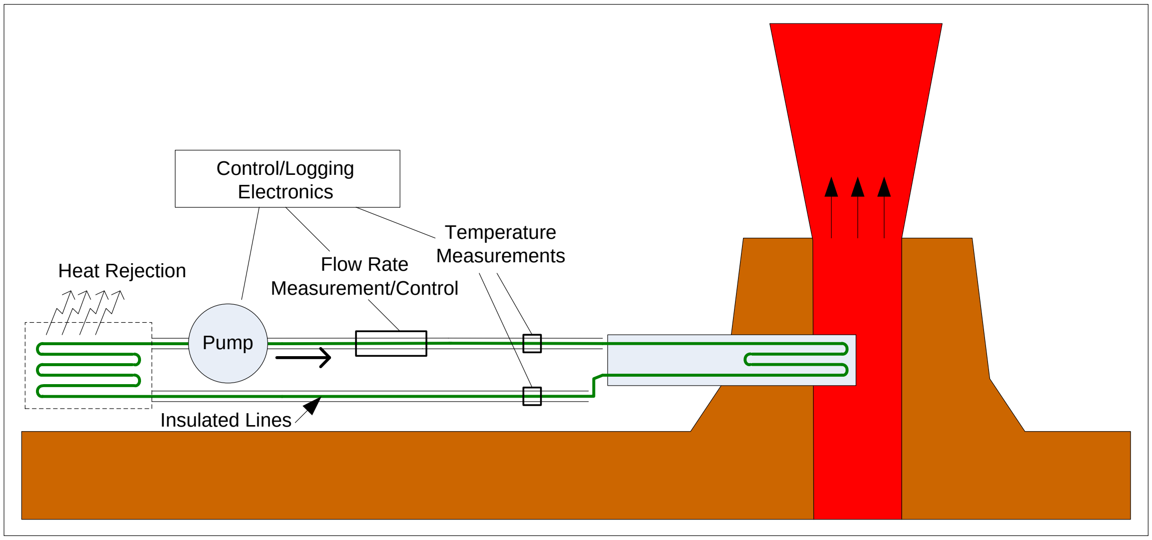

Figure 2: Schematic of proposed next experiment. A working fluid (shown in green) is circulated between a hot side and cold side heat exchanger, demonstrating the transfer of energy out of the vent and to a useful location for use (i.e. conversion to electricity or heating of science equipment).