
**Monitoring CO₂ Emissions in Tree-Kill Areas near the Resurgent Dome at Long Valley Caldera, California** by Deborah Bergfeld and William C. Evans, USGS

**Effects of Geothermal Activity at Casa Diablo**

Since 1995, production of geothermal fluid has caused increases in soil temperature and tree mortality at locations near Casa Diablo and further west in the Basalt Canyon/Shady Rest area.

- These areas form in response to pressure drawdown caused by pumping the fluids which results in vapor separation in the hydrothermal aquifer
- Vapor separation is the formation of superheated steam from superheated geothermal fluid at 350 degrees F

**Observations at Shady Rest Park area**

Two new geothermal production wells were installed by Ormat in 2006 close to Shady Rest Park in 2006. Since pumping began, an area of thermal ground, which is very hot soil at 50 – 90 degrees Celsius (122 – 194 degrees F) 500 meters northeast of the park has increased in size. This has resulted in:

- Increase in area & temperature of thermal ground
- Increased tree-kill
- Increase in hydrogen sulfide gas concentration from <5 ppm to 2000 ppm in 2013

**Increased Production from Proposed CD IV Project**

The proposed CD IV project will add 16 additional wells to the Shady Rest Park area. The increased production will raise annual extractions to 29,000 acre feet per year. This expansion is predicted to cause additional decline in reservoir pressure and an increase in vapor separation. Potential consequence:

- Increased upflow of hot steam and gas
- Additional die offs of mature trees in the broad region of forest in/around the new well field

USGS states that these features do not reflect magmatic unrest. The gases emitted may well be magmatic (carbon dioxide and helium), but their discharge is caused by the reservoir pressure drawdown from the pumping/extraction of geothermal fluid.

**Long Term Observations**

Since the first power station in 1984, and the addition of two more, geothermal associated pressure changes have resulted in increases in steam discharge – M Sorey, USGS, 1998.

Changes in the size of tree kill zone, increases in soil temperatures or steam discharge, and changes in CO2 emissions most likely reflect the response of the shallow hydrothermal system to geothermal fluid production at the Casa Diablo power plant – Bergfeld and Evans, 2011.

While authors agree that some thermal ground, CO2 outflow and stressed vegetation are indeed natural consequence of the shallow hydrothermal outflow, such areas have greatly expanded in recent decades in clear association with geothermal production.

Additional expansion in highly visible areas (i.e., around Shady Rest Park) would likely be unpopular with the public – Bergfeld and Evans.