New Insights on the structure and dynamics of geysers

Jean Vandemeulebrouck[1], Shaul Hurwitz[2], Philippe Roux[4], Robert Sohn[3], Estelle Cros[1]

[1]ISTerre, Universite de Savoie, CNRS, France, [2]U.S. Geological Survey, Menlo Park, USA, [3]Woods Hole Oceanographic Institute, Woods Hole, USA, [4]ISTerre, CNRS, Grenoble, France

E-mail: jvand@univ-savoie.fr

Recent experiments performed at Lone Star Geyser and the reprocessing of seismic ambient noise data collected at Old Faithful Geyser (OFG), both at Yellowstone Nat. Park (USA) provide new insights on the structure and eruption dynamics of these geysers.

Seismic data obtained in 1992 with a dense array around Old Faithful Geyser have been re-processed using acoustic localization techniques (beamforming) to characterize the spatial and temporal patterns of seismic sources inside the geyser conduit. The remarkably energetic, seismo-acoustic activity at OFG is induced by the continuous cavitation of steam bubbles, which occurs in the upper one meter of the water column. Time-dependent localization of this powerful acoustic source during the eruption cycle allows us to track water level and phase separation in the conduit, which in turn provides new insights on the dynamics of the geyser. The distribution of the dominant noise sources at OFG highlights two distinct structures in the geyser subsurface where water boiling is concentrated: the cylindrical geyser conduit, and a previously unknown lateral reservoir. This reservoir is activated during the recharge period at the beginning of each geyser eruption cycle and plays a major role in the oscillatory behavior of the water level in the conduit before each eruption.

Geophysical experiments have been carried out during one week in 2011 at Lone Star geyser, during which seismic ambient noise, ground deformation, acoustic, Infra-red and water flow data from 30 eruptions were collected. We focus here on the dynamics of the pre-play preceding the eruption, in which the conditions required to initiate the eruption are slowly reached. During the pre-play, thermal expansion and oscillation of the fluid into the conduit induces several episodes of water overflow, which are followed after some delay by a very energetic pulse of seismic noise indicating boiling at depth. Eruption starts when these two processes are synchronous.