

The response of geysers to stress and weather perturbations

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Geysers are rare with less than 1,000 worldwide, of which between 200 and 500 occur in the geyser basins of Yellowstone National Park. Their rarity reflects a delicate balance between supply of water, a large supply of heat, and a unique geometry of fractures and porous rocks. Because of the delicate balance between these controlling parameters, only a few geysers display relatively constant intervals between eruptions. Analyzing the sensitivity of geysers to stress perturbations from earthquakes and Earth tide and weather variations, including barometric pressure, precipitation, and wind can yield significant information on cause and effect relationships in these systems, and on the threshold stress perturbation amplitude required to trigger eruptions. Previous studies that examined geyser response to external forcing were based either on sub annual or discontinuous geyser eruption records, and therefore have resulted in conflicting interpretations. To overcome these shortfalls, we analyzed nearly continuous records of eruption patterns of Daisy and Old Faithful geysers in the Upper Geyser Basin of Yellowstone National Park for the period between 2001 and 2011 available from the Geyser Observation Society of America. Geyser eruption times are determined from continuously recording temperature sensors in the geysers outflow channels, and are compared with data on regional and remote earthquakes, barometric pressure, precipitation, wind storms, and calculated theoretical Earth tides. Daisy and Old Faithful geysers were selected for the analysis because they have relatively uniform eruption intervals and long-term records are available. Preliminary results indicate that eruption intervals at Old Faithful slightly shortened in response to the passage of surface waves from only a few large global earthquakes. Daisy Geyser eruption intervals were only modulated after the passage of surface waves from the November 2002 Denali earthquake. Eruption intervals of both geysers are not modulated by earth tides. The results of this study have implications for studying the triggering of volcanic eruptions by external forces. As with volcanoes, stress perturbations in hydrothermal systems can either perturb the nearly saturated fluid, and thus enhance or suppress phase separation and bubble formation, or perturb the surrounding rocks and fractures, both of which may lead to, or delay an eruption. Because geyser eruptions are more frequent and uniform than volcanic eruptions, statistical analysis linking external forces with geyser eruptions rely on much larger datasets, and thus may provide more robust insight on the sensitivity of multiphase erupting systems.