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Transition of characteristic pressure vibration between eruptions in the experimental geyser system

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Geyser is a hot spring that steam and hot water intermittently burst out from the conduit. It has been recognized that there are similarities between geysers and volcanoes in their seismicity; the seismic periodicity known as "banded" seismic activity, volcanic B-type earthquakes and harmonic tremor etc., [Kieffer, 1984]. It should be noted that volcanic B-type earthquakes appear frequently before volcanic eruption. So, the examination of geysers, especially focusing on the precursory vibrations or seismic events, possibly leads to the prediction of volcanic eruption. In order to understand the mechanism of precursory vibration and the relation to the onset of eruption, we set up a simple experimental geyser system, which evokes intermittent burst of steam and hot water [Maeda and Toramaru, Japan Geoscience Union Meeting 2009 abstract]. We observed pressure and temperature in a heated water reservoir and recorded behavior of bubbles by a high speed camera. As a result, it is found that, just after eruption, the temperature of the water in the reservoir decreases and the water of reservoir is insufficiently heated for vapor bubbles to keep its size, the pressure vibration is sharp, namely its amplitude is large and its frequency is higher. On the other hand, a few minute after eruption (interval between aruptions ? 3.5 min), the temperature becomes higher and the water is sufficiently heated for bubbles to be stable, while the pressure vibration became milder, namely its amplitude is relatively small and its frequency is lower. This transition of amplitude in pressure vibration can be interpreted as follows. When temperature is lower, the water is subcooled in large parts of reservoir, the bubbles quickly shrink to negligible size to generate a pressure plus. As temperature rises with time, the degree of superheating increases in lager volume fraction of reservoir. Then bubbles are not ready to collapse generating inactive pressure plus. The transition of frequency in pressure vibration suggests the shift of mechanism from the bubble collapse or shrink to the different process like water column free oscillation. In natural geyser, for example Old Faithful geyser in Yellowstone National Park, U.S.A., the transition in amplitude has been observed, but the transition in frequency has not been documented from the end of eruption to the next. We can expect that in natural geysers the main frequency in water pressure record and seismogram changes with time.

Keywords: geyser, volcano, experiment, tremor, seismicity, analogy