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THE SIGNIFICANCE OF CLATHRATES IN FLUID INCLUSIONS AND THE EVIDENCE FOR OVERPRESSURING IN THE BROADLANDS-OHAAKI GEOTHERMAL SYSTEM, NEW ZEALAND

STUART F. SIMMONS,† MARK P. SIMPSON,

School of Geography, Geology and Environmental Science, University of Auckland, Private Bag 92019, Auckland Mail Centre, Auckland 1142, New Zealand

AND T. JAMES REYNOLDS

FLUID INC., 1401 Wewatta St., no. PH3, Denver, Colorado 80202

Abstract

The Broadlands-Ohaaki geothermal system is host to an epithermal environment where gold-silver transport and deposition involves deeply derived fluids containing up to 3.3 wt percent CO_2 and 0.1 wt percent Cl. Earlier fluid inclusion investigations show that most microthermometric data reflect boiling and mixing in the upper 2 km of the system under modern P-T-X fluid conditions. Here we report the microthermometric results for a single quartz crystal from 1,258-m depth, well Br 25 in the upflow zone of the geothermal system that reveal the presence of clathrates upon freezing due to anomalous concentrations of CO_2 (7.9 to 14.3 wt %). These inclusions occupy the core of the quartz crystal and have homogenization temperatures from 291° to >365°C, but the anomalous concentrations of CO_2 are likely artifacts of deep boiling and heterogeneous trapping of the resulting coexisting gas and liquid phases. Only a few fluid inclusions (T_h ~300°, T_m of –1.4° to –1.6°C), which lack clathrate, reveal more realistic conditions of early quartz precipitation from a modestly overpressured fluid (~140 bars) relative to the prevailing hydrodynamic boiling conditions (110 bars). Microthermometric data (T_h ~300°, T_m of –0.2° to –0.8°C) for fluid inclusions in a later formed overgrowth of the quartz crystal match the modern P-T-X conditions at 1,258-m depth in the well. The overall results of the study show that the clathrates are artifacts of two-phase trapping of steam and liquid and that the deep liquid became overpressured locally, probably due to mineral deposition and sealing of a permeable channel.

†Corresponding author: e-mail, sf.simmons@auckland.ac.nz

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