A HIGH-RESOLUTION INFRARED STUDY OF THE CHEMISTRY OF COMET 17P/HOLMES AFTER ITS OUTBURST. N. Dello Russo1, R. J. Vervack Jr.1, H. A. Weaver1, M. M. Montgomery2, R. Deshpande2, Y. R. Fernández2, and E. L. Martin2,3. 1The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723; (email: neil.dello.russo@jhuapl.edu), 2The Department of Physics, University of Central Florida, Orlando, FL 32816, 3Instituto de Astrofisica de Canarias, 38200 La Laguna, Canary Islands, Spain.

Introduction: In late October 2007, Jupiter-family comet 17P/Holmes experienced an outburst extraordinary both in its timing and scale. The outburst of 17P was exceptional for a number of reasons. First, the outburst occurred at a distance of about 2.4 AU from the Sun on the outbound leg of its orbit, about five months after perihelion (q = 2.05 AU). Second, the outburst was enormous both in terms of increased brightness and spatial scale; the visible coma expanded rapidly and reached a radius larger than the Sun in early November. Third, a similar outburst occurred in 1892 making the comet a naked-eye object, which enabled its discovery by Edwin Holmes on UT 1892 November 6.98. Interestingly, this discovery outburst also occurred about five months after perihelion and at about 2.4 AU from the Sun.

Although the cause of the large outburst in October 2007 is unknown, the resultant large-scale release of material into the coma provided the opportunity to determine the chemical composition of 17P. While recent studies have provided information on the parent molecule abundances in a growing database of comets, Jupiter-family comets remain relatively underrepresented in molecular surveys, leaving a significant gap in our understanding of cometary composition. This study reports the volatile composition of 17P on three dates from high-resolution infrared spectroscopic observations obtained shortly after the initial outburst with the NIRSPEC spectrometer [1] at the W. M. Keck Observatory and the CSHELL spectrometer [2] at the NASA Infrared Telescope Facility on Mauna Kea, Hawaii.

Results: The detection of multiple ro-vibrational lines of H2O, HCN, C2H6 and C2H2 enabled a determination of the rotational temperature of these four coma gases on UT 2007 October 27.6. Derived rotational temperatures were between 60 and 80 K for all measured species [3]. Extension of fluorescence models enabled better constraints to be placed on C2H6 and C2H2 rotational temperatures than is typically possible. In particular the use of ν2 C2H6 lines enabled the determination of the best-constrained C2H6 rotational temperature in a comet to date.

The H2O production rate of 17P (an approximation of the overall volatile productivity of the comet) decreased by approximately a factor of seven between UT October 27.6 and November 2.3 [3]. Production rates were measured in five species (H2O, HCN, C2H6, C2H2, and CH3OH) showing enhanced relative abundances for C2H6, C2H2, HCN, and perhaps CH3OH with respect to H2O in the coma when compared to other comets [3,4]. We note that relative abundance comparisons to other comets should be interpreted cautiously owing to the range in volatilities of the species measured, the large comet heliocentric distance of these measurements (2.45 AU), and evidence of significant release of icy grains outside our aperture [5].

Although these volatile production rates were determined at a larger heliocentric distance than typical spectroscopic measurements of comets, there is evidence that the volatile enhancement in 17P is real (i.e., abundances in 17P can be legitimately compared to abundances measured in comets at smaller heliocentric distances). First, carbon-bearing species are abundant relative to H2O over different aperture sizes. High relative parent volatile abundances C2H2/H2O, C2H6/H2O and HCN/H2O measured in this work are consistent with relative abundances of their photodissociation products C2/OH and CN/OH measured with larger aperture optical narrowband photometry [6]. Second, spatial distributions of all volatiles in the coma measured in this work are consistent with each other and suggest at most only a minor contribution from sublimating icy grains within our aperture [3]. Thus, any icy grain sublimation appears to be approximately uniform for all measured species.

The range of measured volatile chemistries within the comet population reinforces the concept that the relationships among formation regions, evolutionary processing, and measured comet chemistry are poorly understood at this time. The chemical characterization of more comets is needed.