

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. Martin^{2,3}, 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 Astrofísica 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 ν_5 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) de-

creased 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.

References: [1] McLean, I. S. et al. (1998) *Proc. SPIE*, 3354, 566-578. [2] Greene, T. P. et al. (1993) *Proc. SPIE*, 1946, 313-324. [3] Dello Russo, N. et al. (2008) *ApJ*, in press. [4] Bockelée-Morvan, D. et al. (2004) in *Comets II*, eds. M. C. Festou, H. U. Keller, & H. A. Weaver (U. Arizona Press, Tucson, AZ), 391. [5] Yang, B., and Jewitt, D. (2007), IAUC 8892. [6] Schleicher, D. (2007), IAUC 8889.