Comet 103P/Hartley's volatiles within 100 kilometers: Sources of water and volatile dependence on illumination

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Deep Impact acquired unique rotational data set during its close flyby of the hyperactive comet 103P/Hartley 2, the target of the extended DIXI mission (A'Hearn et al., 2011). The closest approach, on November 4, 2010, provided an opportunity to study spatial distribution and absolute abundance changes in gas emission very near the nucleus (< 100 km) as a function of rotation and illumination. In particular, the HRI-IR spectrometer was used to monitor the coma from 1.05–4.85 microns throughout the encounter. Spatially-resolved infrared scans were acquired every 2 hours over the 18 hours prior to closest approach and every 30 minutes for 2 days after closest approach. Water vapor at 2.7 microns, carbon dioxide at 4.3 microns, and bulk organics at $\sim$3.4 microns were the dominant emission bands detected in these spectra and their distribution was found to be highly asymmetric and variable. In particular, the distribution maps and radial profiles from the 8 hours following closest approach, approximately half of the 18.4 hour period of the comet, are unique and provide high spatial resolution ranging from 0.2–3.5 km/pixel. These data allow us to explore correlations among the volatiles and the role of extended sources due to water ice sublimation in the coma. These data will also help to quantify the heterogeneity of the outgassing, explore correlations with illumination, and better locate specific source regions on the nucleus of Hartley 2.

Results to date indicate that carbon dioxide production is tied to the small lobe of the nucleus and persists, although reduced, even when this small lobe is on the night side i.e., not illuminated, suggesting that the small lobe is compositionally distinct. Bulk organics are found to be highly correlated to carbon dioxide. In contrast, water is seen to be a balance of up to three sources. The first component is direct sublimation from the waist region of the nucleus and is highly variable and depends on illumination. The waist water dominates the closest approach maps. The second source is an anti-sunward enhancement, which appears to be more constant and is likely due to sublimation of ice grains that have moved tailward due to radiation pressure. The third is an ambient sunward source that is present, but never dominates, in all the close approach data studied. Efforts are ongoing to quantify these effects and extend them over the entire pre- and post-encounter dataset (-2 days to +8 days).

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References: A'Hearn, M. F. et al., Science, 332, pp. 1396–1400, 2011.