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Parent Volatiles in Comet 9P/Tempel 1: Before and After Deep Impact

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We quantified eight parent volatiles (H2O, C2H6, HCN, CO, CH3OH, H2CO, C2H2, and CH4) in the Jupiter-family comet Tempel-1 using the NIRSPEC high dispersion infrared spectrometer at the Keck-2 telescope on Mauna Kea, Hawaii. Acquired spectra cover the wavelength range 2.9-5.0 um at spectral resolving power ∼24, 000. The abundance ratio for ethane was significantly higher after impact (UT 4 July) but those for methanol and hydrogen cyanide were unchanged. Abundance ratios in the ejecta are similar to those in most Oort-cloud comets, but methanol and acetylene are lower in Tempel-1 by a factor of about two. These chemical similarities suggest that Tempel-1 and most Oort-cloud comets originated in a common region of the protoplanetary disk, consistent with the dynamical view that comet nuclei in the scattered Kuiper-Edgeworth disk (the proposed source reservoir for most ecliptic comets) and those in the Oort-cloud both originated in the outer giant-planets' region of the protoplanetary disk. The depleted ethane abundance before impact and its similarity to values found for 2P/Encke and 21P/ Giacobini-Zinner then suggests that the surfaces of short period comets have been processed thermally. Aspects of the investigation will be discussed. This work was supported by NASA's Planetary Astronomy Program.