THE AGE OF RAYED CRATERS ON MARS IN AN UPDATED GLOBAL SURVEY: POTENTIAL SOURCES FOR MARTIAN METEORITES. L. E. Mc Keown[1], P. M. Grindrod[1], J. K. Harris[2], C. Parenti[3], [1]Natural History Museum, London, UK (l.mckeown@nhm.ac.uk), [2]DEFRA, UK, [3]UNIMORE, Modena, Italy.

Introduction: Mars meteorite candidate source locations can be identified based on three primary factors: (1) the relatively young crystallization ages of most of the meteorites, (2) the minimum size of crater that would have been created by an impact with sufficient energy to eject pieces of the surface out of Mars's atmosphere and gravitational influence, (3) the recent ejection ages of all the meteorites.

Impacts can create a distinctive pattern of radial rays of material around the resulting crater. This pattern degrades with time and is thus an indicator of a young crater. Previous studies [1-4] have identified numerous rayed craters on the surface of Mars large enough to have ejected material, using day and night-time THEMIS imagery.

We have therefore targeted such craters in a systematic survey from the most recent database of martian craters [5] in order to narrow down potential source locations for Mars meteorites. To better constrain age and mineralogical composition of the craters, we have tested the application of (1) thermal infrared TES global mineral abundance maps, (2) near-infrared OMEGA and CRISM data, (3) age dating the ejecta of as many rayed craters as possible, and (4) distinguishing between different formation mechanisms for the rays themselves. Here we concentrate on presenting results of our tests of refining the impact age of rayed craters for comparison with meteorite ejection ages, but also outline our other investigations.

Methods: *Rayed Crater Identification.* Considering the criterion for ejecta reaching escape velocity (crater diameter ≥ 3 km) [3], a total of 71,925 craters ≥ 3 km in diameter were identified between 60°N and 60°S, and analyzed in THEMIS night and day images for the presence of rays. We applied the following criteria for identifying rayed craters: (1) there must be at least two clearly defined radial streaks of a minimum two crater diameter in length, (2) individual rays must be visible in more than one quadrant of the crater surrounds, and (3) rays must not have any morphological or topographical characteristics distinct from the surrounding terrain at THEMIS resolution, they should vary in albedo only. If a crater satisfied all three in either the day or night imagery it was added to the rayed crater catalogue. A rating was assigned to each crater in the catalogue indicating the confidence of the classification, with lower confidence ratings primarily being due to poorer THEMIS image quality.

Refined Crater Age. In order to improve estimates of the both the time of formation of the rayed craters, and the underlying unit onto which they have impacted, we have carried out crater count studies of the ejecta. In each case we have gathered complete CTX image coverage of the rayed crater and associated ejecta, and then counted every crater greater than 100 m in diameter. In dating the crater formation event, we assume that no significant change has occurred to the ejecta (although change is often identifiable through the crater size-frequency analysis). In one case, we have carried out a more detailed crater count study, to (1) demonstrate the potential to date underlying units (equivalent to meteorite crystallization age), (2) compare CTX to HiRISE crater count studies.

TES Mineral Abundances. Thermal infrared data can give information on the mineral composition of the Martian surface but on area scales that are coarse (i.e. the Thermal Emission Spectrometer (TES) global mineral abundance maps have a 3 km pixel size). Therefore, an important caveat to any TES study of these rayed craters is that the spatial resolution will often preclude confident mineral analyses.

CRISM Target Downselection. To derive mineral composition information on smaller size scales requires shorter wavelengths from Visible and Near Infrared (VNIR) instruments such as the Compact Reconnaissance Imager for Mars (CRISM) onboard Mars Reconnaissance Orbiter. Where the Martian dust layer is too thick, instruments such as CRISM cannot see enough of the bedrock underneath to identify its constituent minerals. Using the TES [6] and OMEGA [7] dust coverage maps those craters that could be further investigated using VNIR data were identified, narrowing down the 15 volcanic terrain rayed craters to just 6 in the southern Tharsis region.

Results: *Rayed Crater Identification.* Our approach led to 116 rayed craters being identified, of which 23 had been identified in previous studies [1-4]. All these features have the highest confidence rating of being an impact crater, with the vast majority having a low degradation rating (59 = 3, 53 = 4) in the updated crater database [5]. Rayed craters appear on all terrain ages, as defined by the most recent global geological map. In the case of the Shergottites they are generally accepted to have crystallized approximately 175 – 475 million year ago [8] during the Amazonian epoch. 27 rayed craters lie on terrain identified as Amazonian and Hesperian in the Tanaka et al. [9] geological map. The

Shergottites are predominantly igneous in mineral composition showing little sign of significant in-situ alteration with volcanic units the likely source units. Of the 27 rayed craters on Amazonian and Hesperian terrain, 15 are on volcanic units.

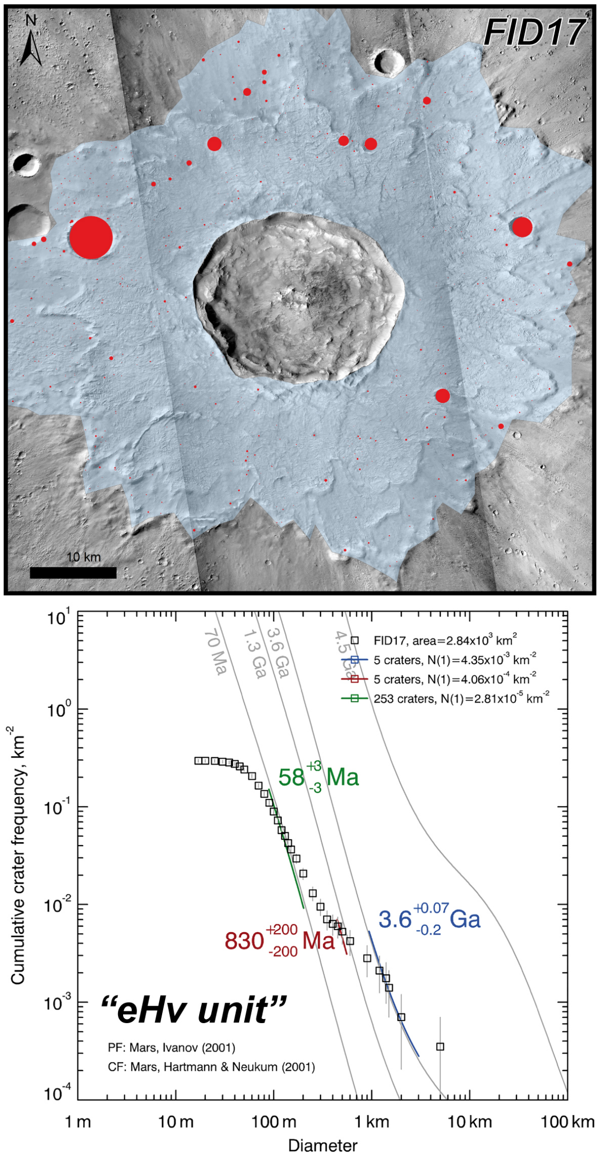

Figure 1. *Example of crater count study at a rayed crater. The crater identification (FID) is given. Colored unit identifies mapped ejecta, red circles are craters >100 m. Crater size-frequency plot is shown below, with some fits given. Global geological map unit [6] is also given for comparison.*

Refined Crater Age. The mean area of ejecta at the rayed craters was 517 km^2, but ranged from 41 to 4401 km^2. The mean number of craters with diameters greater than 100 m on the ejecta was 153, but ranged from 1 to 1700. These variations place limits on our confidence of any derived rayed crater ages [10], but have allowed us to derive preliminary ages for 98 of the 116 rayed craters.

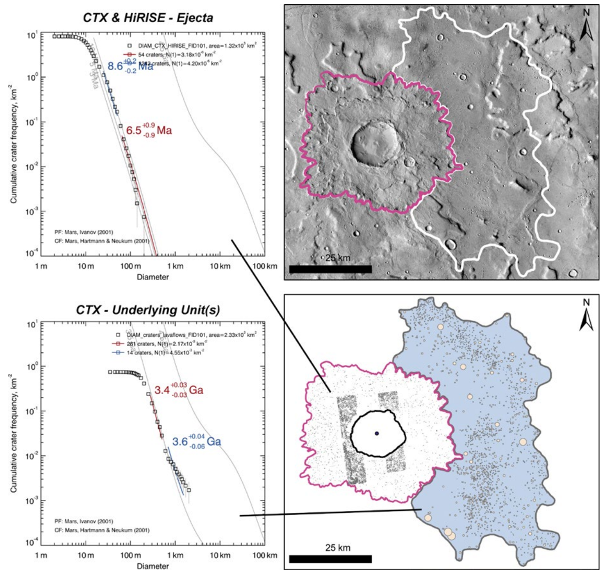

Figure 2. *Examples of detailed crater count study at rayed crater FID101. (TOP) CTX and THEMIS Day image of the rayed crater. (BOTTOM) Mapped craters and units, with corresponding crater size-frequency plots and fitted ages.*

Future Work: All rayed craters will have a formation age estimate (equivalent to meteorite ejection age) derived from our crater count studies, and in some cases we will also be able to derive ages for the underlying units (equivalent to meteorite crystallization age). The 6 rayed craters identified in the southern Tharsis region will be investigated in more depth using all available CRISM images and resulting mineralogy compared to that from the Shergottite class of meteorites. Similar studies can be performed using the rayed crater catalogue as a starting point for the other classes of Martian meteorites.

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