BULK MINERALOGY OF THE TARDA (C2-UNG) 2020 FALL: RESULTS FROM POWDER XRD AND THERMAL (TG-DSC-MSEGA) ANALYSIS.

Laurence A.J. Garvie[1,2] and László Trif[3], [1]Center for Meteorite Studies, [2]School of Earth and Space Exploration, Arizona State University, 781 East Terrace Rd., Tempe, AZ 85287-6004 (lgarvie@asu.edu). [3]Institute of Materials and Environmental Chemistry, Research Center for Natural Sciences, 1117 Budapest, Magyar tudosok korutja 2, Hungary.

Introduction: On the 25th of August, 2020, a meteor streaked across the sky of southern Morocco [1]. The following day the fall associated with this meteor was discovered. Thousands of small, black, fusion-crusted meteorites, for a total mass ~ 4 kg, were found west of the town of Tarda. Classification by the ACE scientists (t**A**rda s**C**ience t**E**am) showed this stone to be mineralogically and isotopically unusual [2]. The meteorite is exceedingly water sensitive and rapidly slakes when wetted with water. The meteorite was approved by the NomCom as a C2-ung. Here, the bulk mineralogy of Tarda is explored using powder x-ray diffraction (XRD) and thermal techniques: TGA – thermogravimetric analysis, DTG – differential thermogravimetric analysis, coupled with MSEGA – mass spectrometric evolved-gas analysis.

Materials and methods:. Powder XRD data were acquired with a Rigaku MiniFlex 600 diffractometer (Cu $K\alpha$ radiation), with a post-diffraction graphite monochromator and automatic divergence slit. Data were acquired from 2° to 65° 2θ at 0.02° steps, and 60 s/step. Samples were prepared from fragments ground to a fine powder and mixed with a few ml of methanol. The resulting slurry was spread into a thin, smooth film on a low-background, single-crystal, quartz plate. The presence of swelling clays was determined by acquiring an XRD pattern after the prepared sample on the quartz plate was placed under ethylene glycol vapor at 60° C for 24 hr.

Thermal measurements were performed on a Setaram LabsysEvo TG-DSC system, in flowing He gas. Samples were run in Al_2O_3 crucibles and heated from 25° to 1000 °C, at 20 °C/min. Data was baseline corrected and processed with Calisto Processing. A 250-point-average Savitzky & Golay smoothing was done on the heat-flow curves. Evolved gases and volatiles were analyzed with a Pfeiffer Vacuum Omni Star™ MS-EGA, connected to the TG-DSC. EGA measurements were done in SEM Bargraph Cycles mode, where the m/z interval of 11-133 was continuously scanned with a speed of 50 ms/amu. The spectrometer was operated in electron-impact mode.

Results: The XRD patterns of Tarda are remakably similar to that from Orgueil, especially in the shape of the low 2θ region [3]. Below <14° 2θ (Panel A) the XRD patterns show two broad reflections: one at 7.4 Å and another with a d-spacing maximum that varies with respect to humidity. XRD data acquried from powder run directly after storage under dry N_2 has a broad maximum near 13 Å, which shifts to 14.7 Å after exposure to damp air. After glycolation the 14.7 Å shifts to 18.51 Å, and a new reflection appears at 8.3 Å. These data are consistent with the smectite, serpentine, and interstratified serpentine/smectite. Orgueil also shows similar behaviour after glycolation [3]. The presence of a non-rational series of 00l reflections is consistent with randomly interstratified serpentine/smectite. In addition, reflections for magnetite, pyrrhotite, carbonates, and forsterite are present (Panel B). The powder patterns suggest several carbonates: dolomite-ankerite, siderite, and calcite. Reflections for tochilinite and sulfates are absent.

The TG mass loss for two samples heated to 1000° C are 16.6 and 17.3%. The corresponding DTG curve shows three prominent features near 100° C, 510 °C, and 760° C, corresponding to signifcant rates of change in the TG mass loss curve (Panel C). The first mass loss step between 60° and 200 °C (Δm – 1.011%), is accompanied by an endotherm corresponds to the release of water, as confirmed by the rise in intensity of the m/z – 18 curve (Panel D). The two mass loss steps between 200 and 400 °C, result in release of SO_2, but in this temperature region the pyrolytic decomposition of other hydrocarbons also takes place. The mass losses starting around 400 °C are attributed to dehydroxylation of phyllosilicates and oxidation of organic matter. The sharp release of CO_2, peaking at 510° C, may be attributed to oxidation of organic carbon. The H_2O maximum at 580° C (Panel D) likely corresponds to phyllosilicate dehydroxylation. The significant mass loss between 710.1° and 811.9° C, with Δm – 2.52%, correlates with further evolution of H_2O and a sharp release of CO near 760° C, likely caused by carbonate decomposition. While calcite decomposes near 900° C, ankerite, siderite and dolomite show a range of decomposition temperatures starting near 520° C [4].
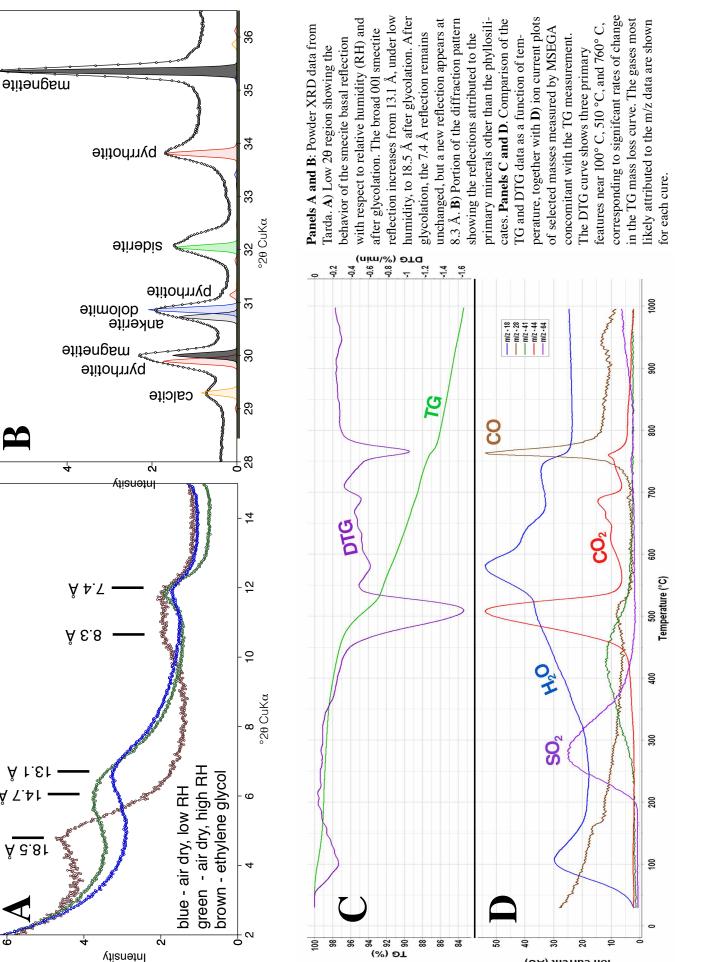
Conclusions: Tarda is dominated by smectite, serpentine, and interstratified serpentine/smectite, with significant magnetite, pyrrhotite, carbonates, and lesser forsterite. Its TG mass-loss near 17 wt% is significantly lower than the mineralogically similar Orgueil [5]. Also, Tarda lacks the 200° to 300° C DTG mass-loss feature attributed to Fe oxyhydroxides present from Orgueil and Ivuna [5]. Tarda is an ungrouped CC that appears to be unique in our collections. The tendency of this meteorite to spectacularly disintigrate with water may explain why further examples of this meteorite type are unknown. The water sensitivity of Tarda further expounds the need for appropriate longterm curation of this and similar meteorite falls.

References: [1] Chennaoui Aoudjehane H. et al. (2021) *51st LPSC*, abstract#1928. [2] Chennaoui Aoudjehane H. et al. (2020) lpi.usra.edu/meteor/metbull.php?code=72644. [3] Garvie L.A.J. (2018) *4*, abstract#2085. [4] Smykatz-Kloss W. (1974) Differential Thermal Analysis, Springer-Verlag, 185 pp. [5] King A.J. et al. (2015) *Planets and Space*, 67:198.

52nd Lunar and Planetary Science Conference 2021 (LPI Contrib. No. 2548)

2446.pdf

Panels A and B: Powder XRD data from Tarda. **A)** Low 2θ region showing the behavior of the smectite basal reflection with respect to relative humidity (RH) and after glycolation. The broad 001 smectite reflection increases from 13.1 Å, under low humidity, to 18.5 Å after glycolation. After glycolation, the 7.4 Å reflection remains unchanged, but a new reflection appears at 8.3 Å. **B)** Portion of the diffraction pattern showing the reflections attributed to the primary minerals other than the phyllosilicates. **Panels C and D.** Comparison of the TG and DTG data as a function of temperature, together with **D)** ion current plots of selected masses measured by MSEGA concomitant with the TG measurement. The DTG curve shows three primary features near 100° C, 510 °C, and 760° C, corresponding to significant rates of change in the TG mass loss curve. The gases most likely attributed to the m/z data are shown for each cure.