THERMAL HISTORY AND STRUCTURE OF THE TAFASSITE PARENT BODY.

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Introduction: Accretion processes in protoplanetary disks produce a diversity of small bodies that contribute to the composition of planets and can survive as asteroids or comets. They played a crucial role in potentially multiple reshuffling events throughout the solar system and in both early and late accretion of terrestrial planets. In the last few years, meteorite analyses have produced fascinating new data. From nucleosynthetic isotopic anomalies, a dichotomy is observed between non-carbonaceous (NC) and carbonaceous (C) meteorites formed within two genetically distinct reservoirs initially located either inside (NC) or outside (C) the orbit of Jupiter that remained isolated for several million years [1]. These isotopic fingerprints can be combined with precise chronology of meteorite parent bodies to constrain dynamical processes, such as the timescale of Jupiter's growth, the inward scattering of C bodies, the incorporation of these objects into the growing terrestrial planets, and the delivery of highly volatile species to Earth.

Tafassite Meteorites: The CR chondrite group includes two subgroups defined based on their alteration (CR1-3) or metamorphism (CR6-7) degrees. This striking contrast challenges the idea of a common origin and could indicate distinct parent bodies. A subgroup of partially differentiated primitive achondrites, isotopically related to the CR2 chondrites, has been identified recently with the suggested group name "Tafassites" [2]. We grouped so far 12 meteorites, currently classified as CR6-7, and ungrouped chondrites achondrites, or primitive achondrites, including (with suggested petrologic types) Northwest Africa 7317 (T6), Tafassasset (T7), Northwest Africa 11561 (T7), Northwest Africa 12455 (depleted T7), and Northwest Africa 7531 (polymict breccia T7) which were investigated in this study. Their mineralogical properties, equilibration temperatures, fO_2, and U-Pb SIMS chronological records [3] provide constraints on the formation and thermal evolution of the Tafassite PB (TPB). Based on reported ^{17}O-^{54}Cr-^{50}Ti isotopic anomalies [4], Tafassites are slightly distinct from CR2 chondrite, Northwest Africa 011 and Northwest Africa 6704 differentiated (ungrouped) achondrite PBs. In the present study, we calculate the evolution of the temperature and the interior structure for TPB. The models are compared to the metamorphic temperatures and thermo-chronological data using an RMS procedure in order to constrain the range of parameters that result in a thermal evolution that fits these requirements.

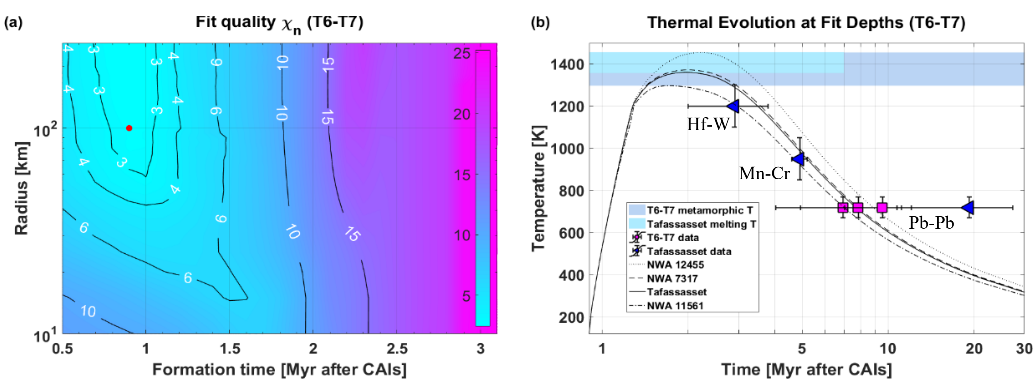

Fig. 1: Fit and thermal evolution of the TPB. (a) Fit quality χ_n as a function of the planetesimal formation time t_0 and radius R that indicates a best-fit accretion time of $t_0 = 0.9 \pm 0.1$ Myr after CAIs and a parent body radius of R>50 km. (b) Representative thermal evolution at the fit depths for Tafassites for a parent body from the best-fit region with χ_n<3 with R=100 km and t_0=0.9 Myr shown in (a) with a red dot. NWA 12455 is fitted at a depth of ~2.8 km (dotted line), NWA 7317 at a depth of ~2 km (dashed line), Tafassasset at a depth of ~1.9 km (solid line), and NWA 11561 at a depth of 1.33 km (dot-dashed line).

Results and Conclusions: Thermal evolution modelling best fits the TPB accretion at 0.9±0.1 Myr after CAIs with a corresponding radius of 100-200 km (Fig. 1). Our results indicate that the TPB is significantly younger than the CR2 chondrite PB (~3-4 Myr [1]) and slightly younger than the proposed accretion ages of ~1.7, 1.5, and 1.7 Myr for the NC primitive achondrite Acapulco-Lodran PB [5] and the CR-related NWA 011 and NWA 6704 grouplet meteorites [4], respectively. The calculated TPB has a fully differentiated interior with a metallic core and silicate mantle below a thin, partially differentiated layer where Tafassites were buried, and a thin, unmelted outer layer. The similar isotopic anomalies, particularly for ^{54}Cr, of CR-related planetesimals suggest that limited radial mixing of carrier grains occurred throughout the period of their parent body accretion (from 1 to 4 Myr after CAIs) within this particular region of the protoplanetary disc.

References: [1] Kruijer T. S. et al. (2020) *Nature Astronomy* 4, 32-40. [2] Ma N. et al. (2021) *Goldschmidt 2021*, Abstract #3852. [3] Schwarz W. H. et al. (2021) *LPSC LII*, Abstract #1981. [4] Sanborn et al. (2019) *Geochimica et Cosmochimica Acta* 245, 577-596. [5] Neumann W. et al. (2018) *Icarus* 311, 146-169.