METEORITES OF THE JURASSIC: POPULATIONS DETERMINED FROM REMNANT EXTRATERRESTRIAL CHROME-SPINELS IN SPANISH LIMESTONE

C. E. Caplan[1,2*], G. R. Huss[2], K. Nagashima[2], and B. Schmitz[3,2], [1]Department of Earth Sciences, University of Hawai‘i at Mānoa, 1680 East-West Road, Honolulu, HI 96822, [2]Hawai‘i Institute of Geophysics and Planetology, University of Hawai‘i at Mānoa, 1680 East-West Road, Honolulu, HI 96822, [3]Department of Physics, University of Lund, P.O. Box 118, Lund SE-22100, Sweden. *caplance@hawaii.edu.

Introduction: The study of meteorites helps us understand solar system processes, but these samples only provide information about what has fallen in the past few thousands of years. Meteorite types have unique characteristics, but they can be altered once they reach Earth. Fortunately, remnant chrome-spinels are preserved throughout Earth's history, and they retain their original characteristics [1-2]. These grains originate from meteorites or micrometeorites and the host-meteorite type for each grain can be determined by measuring element abundances and oxygen isotopes. The overall goal of studying extraterrestrial chrome-spinels is to determine how meteorite populations have changed over time. This study focuses on samples from the Jurassic that were preserved in limestone from the Callovian-Oxfordian boundary (~160 Ma) in Southern Spain, near Carcabuey. Here we determined parent-meteorite types for large- (63-220 µm) and small- (32-63 µm) size fraction grains from Jurassic sediments.

Experimental: Chrome-spinel grains for this study were extracted from limestone at Lund University [e.g., 1]. The grains were mounted in quarter-inch-diameter stainless steel cylinders using epoxy at the University of Hawai'i (UH). The mounts were ground flat and polished using multiple grades of diamond lapping papers. The JEOL JXA-8500F field emission electron microprobe at UH was used to collect major- and minor-element abundances of each grain. Oxygen isotopes were measured using the Cameca ims 1280 ion microprobe (SIMS) at UH. Stillwater chromite was used as the standard for the SIMS and as an additional standard for the electron microprobe [e.g., 3].

Results and Discussion: Our data set consists of 62 large grains and 52 small grains. Multiple measurements were made for most grains and typically showed good reproducibility. Measurements from SIMS pits that intersected cracks or secondary alteration were not used. The two size fractions have similar compositional distributions (Fig. 1).

The grains in this study were classified by comparison with a database of chrome-spinel from modern meteorites. Element abundances provide much of the discriminating power, supplemented by oxygen isotopes. Jurassic grains generally occupy the same compositional space as database grains (Fig. 1). Gaps where the database and the Jurassic data do not overlap may indicate shifts in the population of infalling meteorites over time. Overall, ~30% of the grains were classified as ordinary-chondrite like, ~20% have ureilite, acapulcoite/ lodranite, or carbonaceous chondrite origins, ~10% are possible terrestrial grains, and the remainder are extraterrestrial with unknown parentage (they did not have robust matches using our current chrome-spinel database).

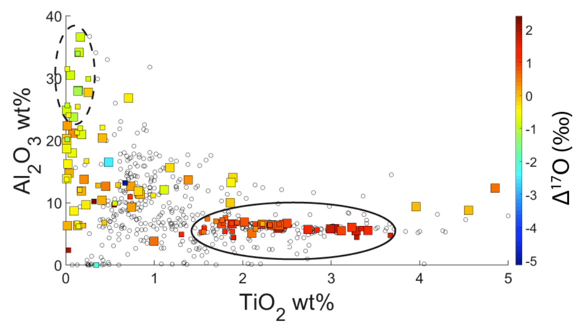

Figure 1: Large (big squares) and small (little squares) chrome-spinels in TiO_2 vs. Al_2O_3 wt%. The $\Delta^{17}O$ (=$\delta^{17}O$-0.52x$\delta^{18}O$) color bar has an uncertainty of ±0.36‰ (2σ). Grey circles from chrome-spinel database of modern meteorites [e.g. 4-7].

Ordinary-chondrite-like grains (solid oval/reddish) form a well-defined cluster with all elements and oxygen isotopes (e.g. Fig. 1). The group of high-Al_2O_3 grains (dashed oval/lime) fall within limited fields based on a variety of elements and oxygen isotopes (e.g. Fig. 1). The database does not contain grains with these high-Al_2O_3 compositions, which suggests that they originated from meteorites not represented in modern meteorite collections. The region between these two groups (0-1 wt% TiO_2 and 5-20 wt% Al_2O_3) contains most of the remaining Jurassic grains (including the ~20% that are classified). This region also contains a majority of the meteorite types that are in the database. It is difficult to classify some grains in this region because of the extensive overlap of different meteorite types. Also, Jurassic grains with low TiO_2 concentrations have very few database counterparts for classification.

References: [1] Schmitz B. (2013) *Chemie der Erde-Geochemistry 73*, 117-145. [2] Schmitz B., et al. (2001) *Earth and Planetary Science Letters 194*, 1-15. [3] Caplan C. E., et al. (2017) *LPSC XLVIII*, Abstract #1690. [4] Wlotzka F. (2005) *Meteoritics & Planetary Science 40*(11), 1673-1702. [5] Goodrich, C. A., et al. (2014) *Geochimica et Cosmochimica Acta 135*, 126-169. [6] Mittlefehldt, D. W. (2015) *Chemie der Erde-Geochemistry 75*(2), 155-183. [7] Keil, K., & McCoy, T. J. (2018) *Chemie der Erde-Geochemistry 78*(2), 153-203. Supported by NASA grant NNX16AQ08G (GRH) and a European Research Council - Advanced Grant (BS).