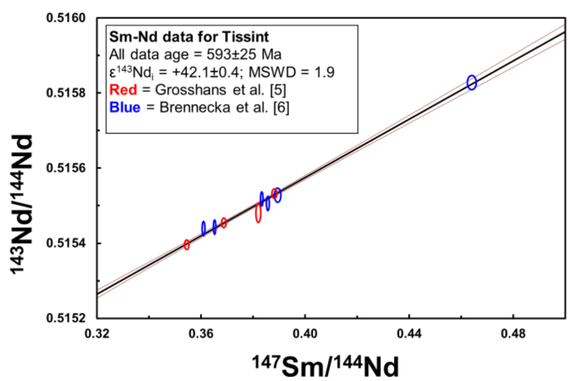
MULTIPLE OLIVINE-PHYRIC SHERGOTTITE STONES OF DIFFERING CRYSTALLIZATION AGE IN THE 2011 TISSINT METEORITE FALL IMPLY IMPACT EXCAVATION FROM A LONG-LIVED DEPLETED MAGMATIC COMPLEX ON MARS (*HINT*: OLYMPUS MONS).

A. J. Irving[1] and T. J. Lapen[2], [1]Dept. of Earth & Space Sciences, Univ. of Washington, Seattle, WA 98195, USA, irvingaj@uw.edu; [2]Dept. of Earth & Atmospheric Sciences, Univ. of Houston, TX, USA, tjlapen@central.uh.edu.

Introduction: The fifth witnessed fall of a Martian meteorite occurred in Morocco on July 18, 2011, and the many stones found (now with an estimated weight of at least 20 kg) were given the name Tissint [1]). The majority of the specimens collected within five months of the fall are broken, partly fusion crusted stones (some with secondary "lip over" crusts), and all appear to consist of petrologically similar olivine-phyric shergottite material. The first petrologic and isotopic studies [2] were conducted on type material reposited at the University of Washington; this comprises numerous small fragments rather than a single intact specimen. Additional data on the same fragment (designated here as UWB1) were given by [3]; other petrologic studies [1, 4] were conducted on different stones.

An Age Dilemma: Three different research groups independently measured Sm-Nd isochrons ***on three different specimens*** to determine crystallization age. A subsample of UWB1 was analyzed at the University of Houston [5], yielding a crystallization age of 616 ± 67 Ma. Material from a different specimen (ASU#1744) was analyzed at Lawrence Livermore National Laboratory, and gave an equivalent age of 587 ± 28 Ma (as well as a Rb-Sr isochron age of 560 ± 30 Ma) [6]. If all these Sm-Nd data are regressed together, a more precise age of 593 ± 25 Ma is obtained (see Figure 1). The initial ε^{143}Nd value of +42.1 implies that both of these specimens are from one of the most depleted mantle sources.



Sm-Nd results for a third specimen (UNM#645) analyzed at the Johnson Space Center [7] differ markedly from those of these first two studies: the Sm-Nd crystallization age was found to be ***120 Ma younger*** at 472 ± 36 Ma (yet with a similar initial ε^{143}Nd value of +44.4). This younger result for the UNM specimen is confirmed by a Rb-Sr isochron age of 495 ± 35 Ma [7]. Given the intralaboratory concordancy of results for different isotopic systems, we can rule out procedural explanations for this startling discrepancy. Furthermore there is little doubt that the different specimens analyzed were anything other than freshly fallen material collected in 2011 in the Tissint strewnfield.

A Bold Hypothesis: We have recently proposed [8] that the common ejection age [9, 10] and mantle source isotopic characteristics for 12 separate (and petrologically distinct) depleted olivine-phyric shergottites (found on three separate continents on Earth) can be taken as evidence for a very long-lived (> 2 Ga) magmatic center on Mars (perhaps situated on Tharsis). A good analogy (although of shorter age span) would be the Columbia River Basalt flood lavas, which range in stratigraphic age from 16 Ma to 6 Ma. A modern impact in central Washington could in principle eject a mixture of shocked basalt fragments from the entire 3 km thick stratigraphic column. If this packet of material landed on the lunar surface over a span of 450,000 years (as did the same olivine-phyric shergottites land on Earth [8, 9]), we could collect them and possibly solve the puzzle of their origin.

However, it also is possible that some of the terrestrial basalt samples from different stratigraphic levels and ages could become mingled during chaotic ejection, travel ***side-by-side*** from Earth to Moon, and land ***together*** as part of a single fall event. This appears to be the inescapable conclusion about the Tissint stones dated so far (and there may well be other Tissint stones with older or younger crystallization ages). Although heterogeneous falls have been documented previously for polymict breccia meteorites (e.g., Almahatta Sitta), here we are proposing that an assumed coherent fall of an unbrecciated achondrite could in fact contain multiple, distinct lithologies (of similar appearance), which in the case of Tissint were detected only fortuitously by specialized dating of randomly-selected specimens.

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