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Re-evaluating bulk H measurements of aubrites using secondary ion mass spectrometry

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It is commonly assumed that early-formed inner solar system planetesimals accreted dry and that Earth accreted most of its water from carbonaceous-chondrite-like (CC) sources. However, analyses of ordinary [1], Rumuruti [2], and enstatite chondrites [3] suggest that water was present in all non-carbonaceous (NC) chondrites, which permits accretion of a significant portion of Earth's water budget from NC-like materials. To better constrain the origin of terrestrial water, it is necessary to characterize the water budgets of all potential building blocks (e.g., NC and CC chondrites and achondrites) and assess the likelihood of water retention during accretion, metamorphism, and differentiation.

Enstatite chondrites (EC's) and aubrites (enstatite achondrites) are highly reduced meteorite groups with similar nucleosynthetic and O isotopic compositions to the bulk Earth [4,5]. Recently, bulk water analyses were conducted on EC's and the Norton County aubrite [3]. Norton County was measured to contain 5300±800 μg/g H_2O in enstatite and 3000±2000 μg/g H_2O in bulk material [3]. If these analyses are correct, this suggests that, despite being highly reduced, aubrites are the wettest achondritic material found to date, and that aubrite-like material could account for a significant fraction of Earth's water budget. These measurements are in sharp contrast to prior *in situ* analyses that suggest that achondrites are extremely H-depleted [e.g., 6-9]. To evaluate this discrepancy, we have conducted *in situ* analyses of enstatite, diopside, forsterite, and plagioclase from a suite of aubrites, including Norton County, revealing very low H contents (~1 – 24 μg/g H_2O; total H quantified as H_2O). We use our data to re-evaluate bulk measurements and more fully constrain the water content of aubrites.

[1] Alexander (2019) GCA; [2] McCanta et al. (2008) GCA; [3] Piani et al. (2020) Science; [4] Burkhardt et al. (2019) GCA; [5] Greenwood et al. (2017) Chem. Erde.; [6] Sarafian et al. (2017) GCA; [7] Sarafian et al. (2019) GCA; [8] Peterson et al. (2023) GCA; [9] Newcombe et al. (2023) Nature