CONSTRAINING THE AGE OF THE VERITAS ASTEROID BREAK-UP EVENT WITH HELIUM-3 FROM THE TORTONIAN MONTE DEI CORVI SECTION IN ITALY

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Introduction: The Veritas family of asteroids in the outer asteroid belt was formed by the collisional disruption of a larger precursor asteroid (with a diameter of ca. 110-140 km). Based on the back-extrapolation of the orbits of some of the known members of the Veritas family, its formation age has been determined to be 8.3±0.5 Ma ago [1], while a statistical approach taking into account the compactness of the family has yielded a similar age of 8.7±1.7 Ma [2]. Farley et al. [3] later found a strong peak of extraterrestrial ^{3}He (from solar-wind-exposed dust) in deep sea sediments deposited at the time, constraining the time of formation to 8.2±0.1 Ma. Since Earth should sample all collisional dust clouds when its dust grains' orbits decay, and this ^{3}He peak is higher than any other in the cenozoic or late mesozoic [3,4], it seems likely that the Veritas break-up was the largest such event in the last 100 Ma. While the ^{3}He peak is a signature of dust delivery, it is unclear whether the Veritas break-up has also delivered meteorites (a possibility we discuss in [5]) and larger asteroids into Earth-crossing orbits, as has been observed in the aftermath of another very large break-up event in the Ordovician (e.g. [6]). Here we report the ^{3}He content and the ^{3}He/^{4}He in acid residues of rocks collected at the Monte dei Corvi section near Ancona in Italy, which serves as the stratigraphic reference point of the Tortonian stage, and has thus been thoroughly characterized and dated (e.g., it has known sedimentation rates), using biostratigraphy, cyclostratigraphy, magnetostratigraphy, and tephrostratigraphy [7].

Methods: Samples from six levels were etched in 10% acetic acid for 24 hours, washed with DI-water and dried at 70°C. He and Ne from aliquots of the residues (ca. 300 mg each) were extracted in a single temperature step (1800°C) and analyzed.

Results & Discussion: The results are presented in Fig. 1. Both the ^{3}He concentration and the ^{3}He/^{4}He ratio show a strong increase (by a factor of ~3) near 8.1 Ma, between samples 2 and 3, at about the age of the sediment bed at 121.4 m (above the base of the Tortonian), which has been dated to 8.132±0.003 Ma [7]. Sample 2 (from 120.1±0.2 m, corresponding to an age of 8.232±0.015 Ma by linear interpolation) and sample 3 (122.0±0.2 m, 8.084±0.016 Ma) thus constrain the beginning of the peak to the interval 8.068-8.247 Ma, compatible with the result by [6]. Additional analyses will further constrain this age. A precise age for the onset of the Veritas break-up event can contribute to the characterization of the Veritas asteroid family members, e.g. their surface and thermal properties which determine their migration rates [1,2,8]. The contribution of fine-grained magnetite to the total magnetic susceptibility shows a peak at the maximal ^{3}He/^{4}He ratio (Fig. 1), possibly due to some extraterrestrial magnetite. The spectral types observed for Veritas family members (Ch/C/Cg, [10]) fit well with CM chondrites (see also [5]), which contain abundant ("framboidal") magnetite in fine-grained form (e.g., [11]).

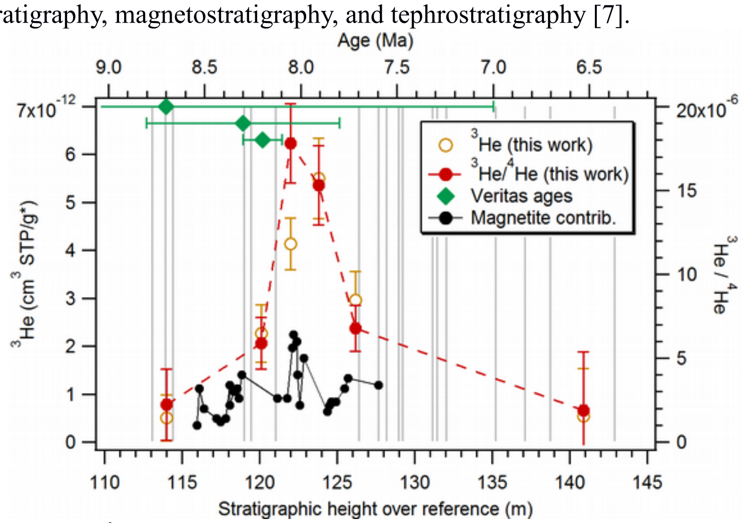

Fig. 1: *^{3}He concentrations (per gram of original sample) and ^{3}He/^{4}He ratios within six samples. The previously suggested Veritas ages (green) are given in the main text. The contribution of magnetite to the total magnetic susceptibility (from [9]) is given as black dots (in arbitrary units). The vertical gray bars represent dated layers [7] with uncertainties typically in the width of the bar. The beginning of the peak is constrained between samples 2 and 3.*

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