(U-Th)/He ZIRCON DATING OF THE CLEARWATER WEST IMPACT STRUCTURE, QUEBEC, CANADA. M.B. Biren[1], M.C. van Soest[1], J-A.Wartho[1], K.V. Hodges[1], M.R. Dence[2] and J.G. Spray[3]. [1]Noble Gas Geochemistry and Geochronology Laboratories, SESE, ASU, PO Box 876004, Tempe, AZ 85287, USA. Contact: marc.biren@asu.edu. [2]Suite 2602, 38 Metropole Private, Ottawa, Ontario, K1Z 1E9, Canada. [3]Planetary and Space Science Centre, University of New Brunswick, 2 Bailey Drive, Fredericton, New Brunswick E3B 5A3, Canada.

Introduction: The ~36 km diameter Clearwater West impact structure, along with its smaller twin (the ~26 km Clearwater East impact structure), forms one of the few known impact doublets on Earth. This study dates zircons from the impact melt sheet at Clearwater West using the (U-Th)/He technique, to compare with the impact ages from previous studies, to further our (U-Th)/He dating studies of terrestrial impact structures [e.g. 1, 2].

Geologic Background: The Clearwater West and Clearwater East structures located in Quebec, Canada (ca. 56°5'N; 74°7'W) were first linked to probable meteorite impacts by Dence et al. in 1965 [3]. An impact origin was later confirmed by way of petrographic, geochemical and structural evidence [4, 5, 6].

The target basement rocks associated with both structures are predominantly Precambrian granite gneisses, granodiorite, and quartz monzonite with lesser occurrences of more mafic rocks (i.e., granulite and metagabbro). Metamorphic grade varies from amphibolite to granulite facies in the basement rocks, and blocks of Ordovician limestone are all that remain of the sedimentary cover that once existed prior to impact [7].

Previous Age Estimates: Clearwater West has been previously dated with a variety of techniques. K-Ar and Rb-Sr methods yielded ages of 285 ± 30, 300 ± 30 and 266 ± 15 Ma [8, 7 and references therein]. Fission track dating of a melt glass yielded an age of ca. 34 Ma [9]. Initial $^{40}Ar/^{39}Ar$ dating of clast-bearing impact melt produced a partially reset age of 445 ± 2 Ma [10]. More recently, Buchner et al. applied the $^{40}Ar/^{39}Ar$ method to optically fresh samples of impact melt rock (drill core chips) to obtain a refined impact age of 283.9 ± 1.2 Ma (2σ, combined weighted mean age from 2 concordant samples; [11]).

Samples, Analytical Procedure, and Results: A ~2.5 kg sample of dark red fine-grained clast-bearing impact melt was originally retrieved from the ring of central islands at Clearwater West during the mid-to-late 1970's [4, 5]. For this (U-Th)/He dating study, the sample was crushed and a heavy mineral concentrate was prepared using standard magnetic and heavy liquid methods. A Leica MZ16 binocular microscope was used to select and accurately measure the dimensions of 10 mostly euhedral zircon grains, ranging in average width from ~55 to 117 µm respectively.

An ASI Alphachron helium extraction system was used to measure ^{4}He concentrations released from each grain by infra-red diode laser heating. U and Th concentrations were subsequently measured on a Thermo iCap Q inductively-coupled-plasma mass-spectrometer following zircon dissolution. Detailed analytical procedures are described in [1].

(U-Th)/He ages were calculated with an iterative process using blank corrected ^{4}He, ^{232}Th, and ^{238}U values (while using the natural abundance to account for ^{235}U). The ages were corrected for alpha-ejection [12], which is the loss of a fraction of the ^{4}He nuclei that are produced from their parent nuclei within the average stopping distance (~18 µm for zircon) from the edge of the crystal and results in anomalously young ages if not corrected for. The resulting corrected (U-Th)/He ages ranged from 156.3 ± 6.8 to 323.8 ± 9.5 Ma (2σ).

Discussion and conclusions: 3 of the (U-Th)/He ages have been interpreted as outliers (i.e., 156.3 ± 6.8; 233.5 ± 6.1; and 323.8 ± 9.5 Ma) and omitted from calculations of the mean impact ages. The remaining 7 ages give an unweighted mean of 284 ± 29 Ma (2σ), and a weighted mean age of 280 ± 12 Ma (95% confidence, MSWD=11.4) using Isoplot v. 3.71 [13]. These new ages clearly overlap with the most recent $^{40}Ar/^{39}Ar$ impact age of 283.9 ± 1.2 Ma [11] and provide us with continued confidence in using the (U-Th)/He technique for dating terrestrial impact structures.

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