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Nb & Sc in 4.4 to 2.7 Ga Zircons: Contrasting Hadean Sources for Jack Hills vs. Barberton

JOHN W. VALLEY[1], TYLER BLUM[2], KEI SHIMIZU[3], KOUKI KITAJIMA[3], MICHAEL J. SPICUZZA[3], NORIKO T. KITA[3], RENAT ALMEEV[4], FRANCOIS HOLTZ[4], ALEXANDER V. SOBOLEV[5] AND AARON J. CAVOSIE[6]

[1]University of Wisconsin-Madison
[2]University of Wisconsin – Madison
[3]University of Wisconsin–Madison
[4]Leibniz University Hannover
[5]Université Grenoble Alpes
[6]Space Science and Technology Centre (SSTC), School of Earth and Planetary Sciences, Curtin University

Presenting Author: valley@geology.wisc.edu

Zircons are the only known Hadean samples from Earth and can preserve detailed records over the past 4.4 billion years. Trace and rare-earth element (TREE) studies of zircon have proposed discriminant diagrams based on Nb-Sc-Ce-Yb-U ratios (Grimes et al. 2015). However, Nb and Sc are less commonly analyzed by SIMS than other TREEs due to higher mass-resolution needed to resolve interferences. Blum et al. (this meeting) report a new analytical method for automated analysis of 26 TREEs, including Nb-Sc by forward-geometry SIMS instruments such as the IMS-1280. Small (ppm-level) adjustments to magnetic-field settings are made each analysis to maintain accurate positioning on relatively sharp peaks (M/DM=12,500). TREEs are calibrated against zircons 91500 and MAD-559.

New analyses of TREEs, including Nb and Sc, from Jack Hills zircons (4.4-3.3Ga) are compared to 4.1-3.3Ga zircons from the Barberton Green Sandstone (BGSS, Drabon et al. 2022) and 2.7Ga zircons from Superior Province rhyolites (SP, Shimizu et al., this meeting). Drabon et al. show increases in U/Nb and Sc/Yb at 3.7-3.8Ga that correlate with transitions from negative to juvenile ε-^{176}Hf(Zrn) values that are reported in seven terrains and interpreted to mark evolution from stagnant-lid to mobile-lid tectonics (Bauer et al. 2020).

The Jack Hills zircons show more variability and muted increases in U/Nb (avg=29, N=173, pre-3.8Ga, vs. 39, N=38, post-3.8Ga) and Sc/Yb (0.20 vs. 0.30); contrasting to BGSS (U/Nb=19, N=36, vs. 48, N=143; Sc/Yb=0.075 vs. 0.25, Drabon). Volcanic zircons from SP are closer to post-3.8Ga JH-zircons than BGSS (U/Nb=18, Sc/Yb=0.16)(N=30, Shimizu). The new JH data strongly contrast with BGSS before 3.8Ga; for instance, 85% of JH analyses are in the “typical arc” domain (Sc/Yb>0.10) vs. 14% for BGSS (Drabon); the rest are mantle-like. The Hadean sources of JH zircons are more continental crust-like (consistent with S.Sobolev,this meeting); JH zircons show a positive correlation of δ^{18}O(Zrn) vs. Sc/Yb and a higher percentage of mildly elevated supracrustal δ^{18}O(Zrn) values (>6.4‰) (44%) vs. BGSS (20%). These differences suggest that the Hadean JH zircons are not derived from similar sources as Barberton and that Hadean parent rocks were more variable and volumetrically important than suggested by a single-source model.