Direct U-Pb Dating of the Marcy Anorthosite, Adirondacks, NY, USA

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Dating has been directly done on igneous zircons from the Marcy anorthosite, Adirondack Mts., NY, USA using SHRIMP II. Anorthosite and related mafic rocks were collected at the Woolen Mill locality near Elizabethtown, NY. A pegmatitic anorthosite (85-90% Plg) yielded prismatic zircons with sector and oscillatory zoning, with a subordinate population having thin, structureless (in CL) rims. The age of the domains with oscillatory zoning is 1151 ± 6 Ma (all errors 2σ). The Woolen Mill metagabbro, mutually cross cutting with anorthosite, has analogous zircon cores within error at 1154 ± 9 Ma. Additional samples of gabbroic and pegmatitic anorthosite contain texturally similar, but low-U zircons, and provide comparable, though less precise, ages. CL textures, uniformity of ages, and calculations of Zr saturation in anorthosites all indicate the zircons with oscillatory zoning are primary igneous crystals, and not inherited xenocrysts.

Thick, structureless (in CL) rims on zircon from the metagabbro truncate delicately zoned igneous cores, are low in U, and imprecisely date a metamorphic zircon growth episode at 1008 ± 32 Ma. Likewise, zircon rims from the pegmatitic anorthosite yield a statistically equivalent age 1012 ± 5 Ma.

Oxygen isotope analyses of bulk zircon splits from the pegmatitic anorthosite yield a value of 8.82 ± 0.02‰ (n=4), in agreement with the high anorthosite W.R. $\delta^{18}O$ (~9‰), and elevated compared to 5.3‰ for zircon in equilibrium with a high T mantle melt. Zircon is retentive of $\delta^{18}O$ values from crystallization, thus the elevated $\delta^{18}O$ values cannot be due to post-magmatic fluid exchange during granulite facies metamorphism, but rather indicate a high $\delta^{18}O$ magmatic source for the Marcy anorthosite.

These results indicate emplacement of the Marcy anorthosite as a high $\delta^{18}O$ crystal mush at ca. 1150 Ma, in agreement with ages determined from granitic rocks that are mutually cross cutting with anorthosite at other localities [1]. A temporally distinct fluid-absent granulite facies metamorphic event followed, with a stage of late metamorphic zircon growth at ca. 1010 Ma.

References

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High precision Cadmium isotopic measurements by MC-ICP-MS

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Cadmium isotopic composition has been studied several years ago [e.g. 1] and more recently [2; 3; 4], in extraterrestrial material and indicates variations of a few per mil per atomic mass unit (amu). Most of the time, Cadmium fractionation is explained by evaporation and condensation processes. These processes may be limited in natural terrestrial environments, so that no terrestrial samples have yet shown any significant and systematic Cd isotopic variations. This study reports Cd isotopic data on samples from urban waste incinerators into which volatilisation and condensation of metals are much likely to occur. Samples representative of refractory /residue phases (CEL-CEC; 150 ppm Cd) and of condensed gas phases (Gat; 350 ppm Cd) have been analysed.

Cadmium has been separated from the matrix using anionic resin AGMP1 [5] with total recovery of 100 percent. Major Sn, Pd and In isobaric interference were monitored and found to be insignificant. Isotopic ratios were measured with a Micromass Isoprobe MC-ICP-MS using the sample standard bracketing method. Results are reported in part per 10000 (ε) per amu relative to the isotopic composition of an in-house Cd standard solution. The reproducibility obtained on standards run during the series of measurements is less +/- 0.05 ε (2 σ, n=48). However, the uncertainty obtained on single samples (n=4) is higher and may reach +/- 0.2 ε.

Samples analysed show a total variation of about 1.5 ε. In a single incinerator, the volatile phases are systematically enriched in light isotopes by 1 ε unit relative to the residue phases. Samples containing both volatile and residue phases yielded an intermediate Cd isotopic composition. These results indicate that, for temperature of 900-1000 °C, $\alpha_{sol-gas}$ is 1 ε amu^{-1}. This value is much lower than the one reported by Sands et al. [2] for lunar soils. This discrepancy might be explained by a difference in the volatilisation temperature and /or kinetic effects, or by the fact that the samples from the incinerator are mixtures and do not represent pure gas and residue phases.

Leaching experiments will be performed on CEL samples in order to separate pure volatile components and residual fractions.

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