Evaluating intercomparability amongst several $^{40}Ar/^{39}Ar$ laboratories

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The Earthtime initiative seeks to achieve a highly precise (ca. ±0.1%) geologic timescale as a basis for reaching a heretofore-unavailable record of several geological and biological processes. To reach this goal, calibration of standards within individual geochronological methods and amongst different methods must be improved. As an outgrowth from the Earthtime I meeting, fifteen $^{40}Ar/^{39}Ar$ laboratories organized an effort to each analyze five common fluence monitors in a blind, full disclosure, experiment. A list of participating laboratories can be found at http:www.earth-time.org. No specific protocol was mandated except that each laboratory would run a split of the sample provided using Fish Canyon Tuff sanidine (FC-2) as the base neutron fluence monitor. The samples chosen include Alder Creek sanidine (~1.1 Ma); Taylor Creek sanidine (~28 Ma); GA1550 biotite (~99 Ma); and PP20 (equivalent to Hb3gr) hornblende (~1071 Ma). In addition, a sanidine separate from a Mid-Tertiary ignimbrite (TS-1a) was provided as a voluntarily unknown. Thus far 8 labs have contributed and until all data are received no rigorous compilation will be presented. The present results confirm that the standards are homogeneous and $^{40}Ar^{*}/^{39}Ar_K$ values relative to FC-2 at 0.05-0.2% (1σ) precision was achieved. Perhaps somewhat surprising, but gratifying, is that intercomparability betweem labs (with minor filtering) was at better than 0.2% for all samples. As expected, each laboratory fought various instrument problems throughout the year and anomalous data could generally be attributed to poor analysis conditions. These experiments indicate that the $^{40}Ar/^{39}Ar$ community is well positioned to produce data that will be intercomparable at a level that corresponds to the goals of the Earthtime initiative. Further refinement and standardizing of protocol for Earthtime research should be considered. For instance, narrowing the number of reactors used for Earthtime samples would allow a concentrated characterization effort. Also, using the standards characterized in this effort would help eliminate errors involved with calibration of in-house standards. Continuing communication efforts and open sharing of ideas and data that have begun through the Earthtime workshops is essential to success.

The role of U-Pb TIMS dating in resolving the causes of mass extinction events

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The P-Tr and K-T boundaries mark the two largest mass extinction events in the rock record. While there is widespread acceptance of a meteorite impact origin for the K-T extinctions, the trigger for the P-Tr extinctions is considerably less certain, but with Siberian flood basalt volcanism generally regarded as a leading suspect, and the case for meteorite impact recently gaining momentum. A new U-Pb TIMS zircon age of 251.7±0.4 Ma for a volcanic bed immediately below the P-Tr boundary, near Heshan, S. China, provides a robust maximum estimate of the boundary age that is identical to previously published U-Pb ages from Siberian flood volcanic rocks (251.1±0.3 and 251.7±0.4 Ma; [1]) and the Noril'sk I intrusion (251.2±0.3 Ma; [2]). These ages provide a rigorous temporal link between the time of the most devastating mass extinction event and the largest Phanerozoic volcanic event.

The resolving power of the U-Pb dating method is widely accepted as unsurpassed, but to maximize its potential requires rigorous assessment of geological and analytical details that can potentially bias data. Small but significant age discrepancies reported by different U-Pb labs for the P-Tr boundary [3-5] emphasize the need for the EARTHTIME inter-laboratory calibration project, which seeks to understand and minimize sources of bias. Our data for the P-Tr boundary and Siberian flood volcanic events have been obtained from the same laboratory, thus circumventing any inter-laboratory calibration biases.

Meteorite impact has also been suggested as the primary trigger to the P-Tr event [e.g. 6], but the evidence presented is controversial [e.g. 7-9]. As in the case of the Deccan volcanism and the Chicxulub impact at the K-T boundary, precise time relations are essential for establishing the feasibility of such theories as large impacts initiating a chain of events leading to massive volcanism, rapid atmospheric-environmental changes, and mass extinction.

References

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