The Manicouagan impact melt rock: A proposed standard for the intercalibration of U-Pb and $^{40}Ar/^{39}Ar$ isotopic systems

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A source of uncertainty in the high-precision intercalibration of U-Pb and $^{40}Ar/^{39}Ar$ geochronology using magmatic minerals is protracted crystallization in complex magma chambers. This has been demonstrated in felsic plutonic and pyroclastic rocks, where magma chamber residence times of >0.3 Myr have been documented. One approach is to find rapidly formed and cooled, homogeneous, magamtic rocks, for which impact melt rocks appear to be an ideal candidate.

The central island of the 65-km-diameter Manicouagan crater in east-central Quebec, Canada is underlain by a sheet of melt rock with an apparent thickness of 230 m. The melt sheet overlies, and is locally mixed with, brecciated basement lithologies of Proterozoic age. The texturally stratified, upward coarsening, melt sheet is marked by an upward reduction in impact-derived clast content. Its chemistry is suggestive of extensive homogenization prior to solidification [1]. Thermal modelling indicates a maximum crystallization duration of about 1600 yr at the core of the melt sheet [2].

Single, 160 to 300 µm-size, zircons from the highest levels of the melt sheet analysed so far by ID-TIMS have consistently produced $^{206}Pb/^{238}U$ dates of ca. 215.5 Ma. No indications of inheritence from older zircon have been detected. These results are in agreement with previously reported U-Pb zircon dates of Hodych and Dunning [3]. Ar systemtics are complex but a preliminary $^{40}Ar/^{39}Ar$ sanidine plateau age of ca. 213 Ma by Shepard [4] is encouraging. We propose the demonstrably melt-derived zircon and sanidine in Manicouagan as new potential standards for the high-precision intercalibration of the U-Pb and $^{40}Ar/^{39}Ar$ isotopic systems. In addition, this study confirms the conclusions of Hodych and Dunning [3] that the impact does not coincide with the Triassic-Jurassic extinction at ca. 200 Ma.

References

[1] Grieve, R.A.F. and Floran R.J., (1978), *J. Geophys. Res.* **83**(B6), 2761-2771
[2] Onorato P.I.K. and Uhlmann D.R., (1978), *J. Geophys. Res.* **83**(B6), 2789-2798
[3] Hodych J.P. and Dunning G.R., (1992), *Geology* **20**, 51-54
[4] Shepard, J.B., (1986), *unpub. B.A. thesis*.

Intercalibration of the U-Pb and $^{40}Ar/^{39}Ar$ geochronometers: Status, prognosis, and proscription

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The $^{40}Ar/^{39}Ar$ method is comparable to U-Pb in terms of precision and possession of internal reliability criteria. Intrinsic limitations favor U-Pb in the pre-Mesozoic, and $^{40}Ar/^{39}Ar$ for the Cenozoic. Nonetheless, the substantial overlap in routine applicability dictates that these two geochronometers be well intercalibrated in order to achieve an accurate and highly resolved time scale. Existing uncertainties (e.g. in decay constants and $^{40}K/^{40}Ar$ data for standards) in calibration of the $^{40}Ar/^{39}Ar$ method yield ab-solute age uncertainties of approximately 2%, roughly an order of magnitude worse than for U-Pb. While independent improved calibration of the $^{40}Ar/^{39}Ar$ method is worth-while, it is equally valid and in some ways more desirable to effectively normalize the $^{40}Ar/^{39}Ar$ to the U-Pb system. Such a program has been ongoing at BGC for 7 years, and has produced 15 data pairs for volcanic rocks of Cenozoic-Proterozoic age. Volcanic rocks are critical to avoiding decoupled isotopic systems due to slow cooling. From this data set, complemented by several U-Pb data from MIT, approximately –1% bias ($^{40}Ar/^{39}Ar$ relative to U-Pb) is evident. Under the stimulus of EARTHTIME, more such data are likely to be generated in the future. The statistical methods of Kwon et al. (2002) permit simultaneous derivation of both the ^{40}K total decay constant and the age of a standard. Values determined by this approach are already better than 0.5% in 1σ precision and will improve with increased data input. It will be critical in going forward that data used for this purpose be of the highest possible quality for both systems. Obviously, both systems must be applied to minerals separated from the exact same rock. Data from intrusive rocks, though perhaps illustrative, are inappropriate for quantitative use. $^{40}Ar/^{39}Ar$ data must have rigorously controlled neutron fluence relative to a well-intercalibrated standard (e.g., FCs) and be demonstrably free of effects due to alteration, secondary degassing, recoil, and excess argon. U-Pb data must be free of Pb-loss and inheritance effects, as best deduced from ID-TIMS analysis of single zircons using the annealing/chemical abrasion technique.

Reference

Kwon et al. (2002) *Math. Geol.* 34: 457-474