1.3.14

U-Pb dating of detrital zircons by multiple ion counting LA-MC-ICP-MS

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The Nu Plasma MC-ICP-MS instrument at the University of Alberta has been fitted with a modified collector block that houses 12 Faraday collectors, and three ion multipliers dispersed on the low mass side of the collector array. Multiple ion counting eliminates the need for 'peak-jumping' acquistion of small ion beams through a single collector (i.e. more effective ion beam usage), and potentially increasing the spatial resolution for laser ablation studies. The collector configuration allows for the simultaneous acquistion of ion signals ranging in mass from ^{238}U to ^{203}Tl, an important factor in obtaining high precision U-Pb age determinations. ^{207}Pb, ^{206}Pb, and ^{204}Pb (+^{204}Hg) signals are measured on ion counting channels, whereas U and Tl isotopes are measured on Faraday collectors. Faraday-ion counter bias is monitored for each analytical session using a mixed 0.4 ppb standard solution of Pb (NIST SRM 981) and Tl (NIST SRM 997). During a ~10 hour period, the stability of the multiplier biases varies between 0.2 to 0.5%. Routine analysis consists of a 30 second blank measurement prior to the start of ablation, which includes correction of the ^{204}Hg contribution (~700 to 1000 cps). Prior to the start of ablation, a ~2 ppb solution of Tl is aspirated into the ICP source using a desolvating system (DSN- Nu Plasma). The Tl is mixed with ablated particles generated by a Nd:YAG 213 nm laser system (New Wave Research) in a He atmosphere (flow rate 1.00 L/min.). All ablation experiments (30 seconds) were conducted using low laser pulse energies (between 2 to 3 Jcm^{-2}) so as to not generate ^{206}Pb ion signals $>2\times10^6$ cps. Instrument sensitivity and inter-element U and Pb fractionation are positively correlated with the DSN membrane (Ar) gas flow rate (3.30 to 3.50 L/min.). An in-house zircon standard, previously dated by ID-TIMS, containing ~100 and ~300 ppm of Pb and U, respectively typically yields 500,000 cps of ^{206}Pb using a 40 micron spot size. External reproducibilites (2σ) of the ^{206}Pb/^{238}U and ^{207}Pb/^{206}Pb values during one analytical session are typically 3 to 4% and $\leq$ 1%, respectively based on repeated measurements of the internal zircon standard. Correction for instrumental drift during ablation of unknown zircons is achieved by a 'standard-sample' bracketing technique. Use of multiple ion counters facilitates accurate measurement of the ^{206}Pb/^{204}Pb value so as to correct for the common Pb component; this is important for zircon analyses with ^{206}Pb/^{204}Pb <2000. We demonstrate the effective use of this technique for studies of detrital zircon populations.

1.3.15

In-situ high precision Hf isotope ratio measurement using laser ablation MC-ICPMS: Mass bias and isobaric interference corrections

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The application of in-situ isotope ratio measurements by laser ablation MC-ICPMS has been demonstrated for a number of radiogenic and stable isotope systems. The accuracy and precision of the in-situ data are dependent on a number of factors, including corrections for mass bias and spectral interferences, as well as matrix effects. One of the advantages of the MC-ICPMS technique is that overlap corrections can be made for isobaric interferences, however laser ablation is the ultimate test of these correction procedures as there is no sample purification. Mass bias corrections need to be applied to the isotopes of the interfering element as well as to the element of interest. In many systems the mass fractionation of interfering isotopes can be measured independently but in others this is not possible. The measurement of Hf isotopes is complicated by the isobaric inteferences of Yb and Lu on ^{176}Hf. The mass fractionation of Yb and Hf can be measured independently but Lu has only 2 isotopes, one of which is mass 176. Here the mass bias behaviour of Lu must be assumed to be the same as either Yb or Hf.

Results obtained on a Nu Plasma MC-ICPMS will be presented to show the mass bias relationships between Er, Yb, Lu and Hf. Over a range of normal operating conditions the ratios of the mass fractionation coefficients for pairs of these elements remain constant, but non-equal. The long-term reproducibility of the ratios allows the adjustment of the 'true' isotopic ratio of Yb or Lu, or the use of a mass fractionation 'factor' for external mass bias normalisation to Hf. The results will also be used to show the dependency of mass fractionation coefficients on factors such as plasma operating conditions (nebuliser gas flow, gas composition, torch position), plasma loading (matrix effects) and extraction lens settings.