Uncertainties of LA-ICPMS U-Pb zircon ages caused by the use of different data reduction software

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Publications and interpretations based on isotope analyses of geological materials by laser ablation ICPMS appear with ever increasing frequency in the scientific literature. The apparent ease and speed with which such data can be gathered leads to voluminous data production and statistical manipulation of data can easily becomes synonymous with quality. Consideration of data correction procedures and uncertainty estimation/calculation combined with knowledge of geological, geochemical and analytical phenomena is crucial for the interpretation of data and understanding of the results.

Having acquired LA-ICPMS data mass bias and other corrections (gas blank, common lead, detector deadtime etc.) need to be applied, isotope ratios have to be calculated and uncertainties needs to be assessed before the final age can be interpreted. Although one fundamental limitation of the LA-ICPMS zircon dating technique is the element fraction, most of the published data reduce the $^{206}Pb/^{238}U$ age error less than 1-2% (2SE), or even less than 1% (e.g. [1]).

Our data set consists of several available standard zircons (Plesovice, GJ1, Mud Tank, LAC, 91500) as sample material together with the GJ1(GJ1-68) as an external standard. The $^{206}Pb/^{238}U$, $^{207}Pb/^{235}U$ and $^{207}Pb/^{206}Pb$ ratios of the GJ1-68 were determined by ID-TIMS measurements. Samples were measured with a homogenized 193nm eximer laser ablation system, in combination with a quadrupole ICP-MS. For data reduction we use different software packages: Sills, Lamtrace, Glitter, PepiAge, Lamdate,UPb_age.r., which are available on the market. The obtained $^{206}Pb/^{238}U$ ages and errors differ significantly depending of the applied software. These results with their large scatter of the mean $^{206}Pb/^{238}U$ ages raise a question about the error uncertainties of the published LA-ICPMS ages of less than 1% in the best measured $^{206}Pb/^{238}U$ ratio, having in mind that even the use of different software reduction programs can lead to larger clusters of the data. Therefore it seems questionable to start modeling short-lived geological processes (e.g. magma intrusion pulses) with such type of data precision and we like to ask: Do we have an underestimation of the error?

[1] Harris *et al.* (2004) *Miner Deposita* 39: 46-67

Groundwater recharge in the North China Plain determined by environmental tracer methods

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Intensive agriculture in the densely populated North China Plain (NCP) considerably taps into groundwater resources, causing a continuous decline of water tables. We employed environmental tracers (^3H-^3He, noble gases, stable isotopes, SF_6) to study groundwater recharge in the NCP.

Groundwater in the unconfined parts of the piedmont plain exhibits ^3H-^3He ages of less than 40 a. Ages correlate with well depth supporting an areally distributed infiltration. Combined with the steady water table descent, an area-wide recharge rate of about 0.4 m/a was estimated. Despite the recycling of irrigation water, a balance deficit due to enhanced evapotranspiration by intensive agriculture remains, causing the depletion of the aquifers.

An increase of stable isotope ratios in the youngest groundwater, which is similar in magnitude to climate-related differences over much longer periods, was observed [1]. This appears to reflect anthropogenic modifications of the natural recharge regime, such as less seasonality of precipitation recharge, a higher contribution of enriched water from the adjacent mountain area, or evaporation during irrigation in the pumping and re-infiltration cycles.

All samples contained SF_6, even from wells with ^3H-free waters. SF_6 ages are systematically biased towards too young ages compared to ^3H-^3He ages. Terrigenic SF_6 seems to be steadily accumulating in the groundwater, as indicated by a correlation of the nonatmospheric SF_6 excess with ^3H-^3He ages. The applicability of SF_6 as dating tracer is strongly restricted in the sedimentary basin of the NCP.

[1] Kreuzer *et al*. (2009) *Chem. Geol*. **259**, 168–180.