

# Geological Society of London: Reporting standards for $^{40}\text{Ar}$ - $^{39}\text{Ar}$ and U-Pb geochronometric data

## Common to all datasets

- Location of each sample in latitude/longitude format, with datum.
- Although separately formatted tables may be included, data should also be included in digital spreadsheet format, with each value in a separate column. This will allow for easier validation of data by reviewers and editors.
- All units of measure must be explicitly stated.
- Appropriate significant figures on all presented data.

## $^{40}\text{Ar}$ - $^{39}\text{Ar}$

### *Data required in main body of text*

- Explicitly stated confidence level for all uncertainties.  
*Recommendation 1:*  $2\sigma$  for all uncertainties quoted in body of text.  
*Recommendation 2:* Explicit restatement of confidence level used in associated tables, appendices or repository items containing data.
- Name of laboratory providing analytical data.
- Reference to source of decay constant values.  
*Recommendation:* Steiger & Jäger (1977).
- Minerals or materials analysed
- Name, apparent age and associated uncertainties of neutron fluence monitor used, and reference to source of primary calibration or intercalibration data.  
*Recommendation:* The following monitors are considered to be internationally accepted and their use is encouraged:
  - FCT-San
  - Hb3gr hornblende
  - TCR-San
  - GA1550 Biotite
  - AC-San
- Analytical technique (e.g. furnace step-heat on single grains)

### *Data required for data table*

- Sample identifier (as used in main body of text) and analysis identifier (for step-heating data, this would be laser power or heating temperature).
- J -factor and uncertainty.
- One of the following formats:
  - (1) Relative abundances and uncertainty (and volume, atomic or mass units) of  $^{40}\text{Ar}$ ,  $^{39}\text{Ar}$ ,  $^{38}\text{Ar}$ ,  $^{37}\text{Ar}$ ,  $^{36}\text{Ar}$  or
  - (2) Ratio to common denominator with uncertainty, and relative abundance of denominator with its uncertainty (e.g.  $^{36}\text{Ar}/^{39}\text{Ar}$ ,  $^{37}\text{Ar}/^{39}\text{Ar}$ ,  $^{38}\text{Ar}/^{39}\text{Ar}$ , and  $^{40}\text{Ar}/^{39}\text{Ar}$  and  $^{39}\text{Ar}$ ).*Recommendation:* Format (1) because any ratio can then be directly derived.
- Fraction of total sample  $^{39}\text{Ar}$  released (for step heat analyses).

- $^{40}\text{Ar}^*/^{39}\text{Ar}$  and uncertainty
- Apparent age and uncertainty.  
*Recommendation:* J-factor uncertainty is to be propagated only into the final age.
- Footnote stating corrections and their magnitude that are applied to abundances.  
*Recommendation:* Abundances should be corrected for background, mass discrimination, and radioactive decay and interfering nuclear isotopes.
- Either by footnote, column header or combination of both, state confidence level for all uncertainties and whether they are fractional or absolute values.
- Optionally, other parameters such as %  $^{40}\text{Ar}^*$ , Ca/K, or Cl/K, may be included

*The following data must appear in at least one of main body of text, methodology section in appendix or as footnote in data table*

- Description of data reduction methodology, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) basis of data reduction and associated statistical methods, (2) basis for calculation of J-factor, (3) basis for calculation of backgrounds (blank), (4) basis for calculation of mass discrimination.
- Reactor name.
- Value and uncertainty of mass discrimination.
- Values of nuclear interfering reactions and uncertainties for  $(^{40}\text{Ar}/^{39}\text{Ar})_{\text{K}}$ ,  $(^{39}\text{Ar}/^{37}\text{Ar})_{\text{Ca}}$ , and  $(^{36}\text{Ar}/^{37}\text{Ar})_{\text{K}}$  and either explicitly or by reference, methodology used for their determination.
- Background (blank) levels and uncertainties for  $^{40}\text{Ar}$ ,  $^{39}\text{Ar}$ ,  $^{38}\text{Ar}$ ,  $^{37}\text{Ar}$ ,  $^{36}\text{Ar}$ .  
*Recommendation:* The measured range of each value may be given if the variability is reasonably low.

## **U-Pb ID-TIMS**

*Data required in main body of text*

- Explicitly stated confidence level for all uncertainties.  
*Recommendation 1:*  $2\sigma$  for all uncertainties quoted in body of text.  
*Recommendation 2:* Explicit restatement of confidence level used in associated tables, appendices or repository items containing data.
- Name of laboratory providing analytical data.
- Minerals or materials analysed
- Reference to source of decay constant values.  
*Recommendation:* Steiger & Jäger (1977).

*Data required for data table*

- Sample identifier (as used in main body of text) and fraction identifier.
- Either by footnote, column header or combination of both, state confidence level for all uncertainties and whether they are fractional or absolute values.
- Fraction weight in micrograms.  
*Optional:* number of grains analysed
- Concentration of radiogenic U and Pb in ppm.
- Measured  $^{206}\text{Pb}/^{204}\text{Pb}$  corrected for spike and fractionation.

- $^{208}\text{Pb}^*/^{206}\text{Pb}^*$  or model Th/U  
*Optional:* To also include uncertainty.
- Isotopic ratios  $^{206}\text{Pb}^*/^{238}\text{U}$ ,  $^{207}\text{Pb}^*/^{235}\text{U}$  and uncertainties.
- One of the following formats:  
(1) Isotopic ratio  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  and uncertainty *or*  
(2) Isotopic ratio  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  and associated correlation coefficient  
*Recommendation:* Format (1) because of explicit statement of uncertainty.
- Calculated age and uncertainty derived from each of  $^{206}\text{Pb}^*/^{238}\text{U}$ ,  $^{207}\text{Pb}^*/^{235}\text{U}$  and  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$
- Optionally, other parameters such as percent discordance or calculated common Pb content may be included.

*The following data must appear in at least one of main body of text, methodology section in appendix, or as footnote in data table*

- Description of data reduction methodology, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) basis of data reduction and associated statistical methods, (2) basis for calculation of blanks or (3) basis for calculation of mass discrimination.
- Description of mineral or material preparation, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) methodology for concentration of analysed material, (2) selection criteria for analysed material, (3) any modification to material, such as air or chemical abrasion.
- Description of chemical preparation techniques, either explicitly or by reference.
- Spike composition and uncertainty on calibration of main isotopic U/Pb ratio (e.g.  $^{235}\text{U}/^{205}\text{Pb}$ )
- Description of instrumentation and its analytical protocols, either explicitly or by reference.
- Value and uncertainties of applied common  $^{206}\text{Pb}/^{204}\text{Pb}$ ,  $^{207}\text{Pb}/^{204}\text{Pb}$  and  $^{208}\text{Pb}/^{204}\text{Pb}$  corrections, along with methodology of determination, either explicitly or by reference.
- Blank levels for Pb and U (in pg),  
*Recommendation:* The measured range of the blank levels may be given if the variability is reasonably low.
- Pb isotopic composition of blank with uncertainty stated as  $^{206}\text{Pb}/^{204}\text{Pb}$ ,  $^{207}\text{Pb}/^{204}\text{Pb}$  and  $^{208}\text{Pb}/^{204}\text{Pb}$ .

## U-Pb HR-SIMS

*Data required in main body of text*

- Explicitly stated confidence level for all uncertainties.  
*Recommendation 1:*  $2\sigma$  for all uncertainties quoted in body of text.  
*Recommendation 2:* Explicit restatement of confidence level used in associated tables, appendices or repository items containing data.
- Name of laboratory providing analytical data.
- Minerals or materials analysed
- Reference to source of decay constant values.  
*Recommendation:* Steiger & Jäger (1977).
- Name of U/Pb calibration reference,  $^{206}\text{Pb}^*/^{238}\text{U}$  age, resultant external uncertainty on the calibration, and reference to source of primary calibration or intercalibration data.

*Data required for data table*

- Sample identifier (as used in main body of text) and analysis identifier.

- Either by footnote, column header or combination of both, state confidence level for all uncertainties and whether they are fractional or absolute values.
- Concentration of U, Pb (total or radiogenic) in ppm.  
*Recommendation:* To also include Th in ppm or Th/U ratio.
- Measured  $^{204}\text{Pb}/^{206}\text{Pb}$  and/or calculated fraction of common  $^{206}\text{Pb}$  ( $f_{206}$ ) with statement in footnotes. Composition ( $^{207}\text{Pb}/^{206}\text{Pb}$  ratio) assumed for common Pb (can be a footnote statement if common to all analyses).
- Isotopic ratios: common Pb corrected  $^{206}\text{Pb}^*/^{238}\text{U}$ ,  $^{207}\text{Pb}^*/^{235}\text{U}$ , (optional  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$ ) and uncertainties together with error correlation ( $\rho$ ) when plotting conventional (Wetherill concordia) or  $^{206}\text{Pb}^*/^{238}\text{U}$  and  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  when plotting inverse (Tera–Wasserburg) concordia.  
*Recommendation:* Tabulated data preferably should match plot axes used in figures (i.e. conventional or inverse concordia).
- Calculated age and uncertainty derived from each of: Common Pb corrected  $^{206}\text{Pb}^*/^{238}\text{U}$ , (optional  $^{207}\text{Pb}^*/^{235}\text{U}$ ),  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  and uncertainties. Where appropriate  $^{207}\text{Pb}$  corrected ages and uncertainties calculated from combined uncorrected  $^{206}\text{Pb}/^{238}\text{U}$ ,  $^{207}\text{Pb}/^{206}\text{Pb}$  ratios may also be presented.
- Optionally, other parameters such as % discordance,  $^{208}\text{Pb}^*/^{206}\text{Pb}^*$  (with uncertainties) or calculated common Pb content may be included, but are not required.

*The following data must appear in at least one of main body of text, methodology section in appendix, or as footnote in data table*

- Description of data reduction methodology, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) basis of data reduction and associated statistical methods, (2) basis for assumption of common Pb composition, (3) basis for estimation of mass fractionation (if applied).
- Description of mineral or material preparation, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) methodology for concentration of analysed material, (2) selection criteria for analysed material, (3) mount preparation procedures or (4) description of any electro-conductive coating applied to mount.
- Description of instrumentation and its analytical protocols, either explicitly or by reference.  
*Note:* This should include or reference, at a minimum (1) primary ion beam type and size, (2) isotopes/species measured, (3) mass resolution, (4) detection settings (e.g. mono- or multi-collection).

## **U (Th)-Pb LA-ICPMS<sup>a</sup>**

*The following data must appear in at least one of main body of text, methodology section in appendix, or as footnote in data table*

- Minerals or materials analysed.
- Name of laboratory providing analytical data.
- Description of mineral or material preparation, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) methodology for concentration of analysed material, unless analysed *in situ*, (2) selection criteria for analysed material, (3) mount preparation procedures, (4) description of imaging techniques, such as CL, BSE, etc., in case they were used for characterization of the analysed material.
- Description of instrumentation and its analytical protocols, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) type of laser and ICPMS used, (2) laser parameters (e.g. wavelength, fluence, spot size, repetition rate, mode of sampling, laser sample gas), (3) ICPMS parameters

(e.g. plasma power and plasma gas flows, type of detector and detection mode (sequential or simultaneous), isotopes/species measured, measurement dwell and settling times, number of measurements/readings per analysis, length of blank/sample measurements).

- Description of data reduction methodology, either explicitly or by reference.  
*Note:* This should include or reference at a minimum (1) basis of data reduction, including all corrections applied to the raw data (e.g. blank, laser-induced fractionation, mass discrimination, interference, common Pb and basis for assumption of common Pb composition<sup>b</sup>, (2) calibration strategy, (3) used calibration standards and their  $^{206}\text{Pb}^*/^{238}\text{U}$  and  $^{207}\text{Pb}^*/^{235}\text{U}$  ( $^{208}\text{Pb}^*/^{232}\text{Th}$ ) ages and associated uncertainties.
- Description or reference to calculation of analytical uncertainties and explicitly stated confidence level for all uncertainties.  
*Note:* This should include or reference at a minimum (1) basis of uncertainty calculation (2) list of all sources of uncertainties included in the estimate of isotopic ratio/age uncertainties, (3) estimate of precision and accuracy (e.g. based on analysis of reference sample) of the technique.  
*Recommendation 1:*  $2\sigma$  for all uncertainties quoted in body of text.  
*Recommendation 2:* Explicit statement of confidence level used in the text, figures, associated tables, appendices or repository items containing data.
- Description of U/Pb (Th/Pb) reference sample.  
*Note:* This should include name and source, U (Th) and Pb contents,  $^{206}\text{Pb}^*/^{238}\text{U}$  and  $^{207}\text{Pb}^*/^{235}\text{U}$  ( $^{208}\text{Pb}^*/^{232}\text{Th}$ ) ages and associated uncertainties, results achieved by repeat measurement of the reference sample and their uncertainties.
- Description of age calculation and reference to source of decay constant values.  
*Note:* This should include or reference the calculation procedure used for age calculation and source/values of decay constants.  
*Recommendation:* Steiger & Jäger (1977).

### *Data required for data table*

- Sample identifier (as used in main body of text) and analysis identifier.
- Either by footnote, column header or combination of both, state confidence level for all uncertainties and whether they are fractional or absolute values.
- Optional: concentration of U (Th), Pb (total or radiogenic) in ppm.
- Measured  $^{204}\text{Pb}/^{206}\text{Pb}^b$
- Isotopic ratios: Common Pb corrected<sup>b</sup>  $^{206}\text{Pb}^*/^{238}\text{U}$ ,  $^{207}\text{Pb}^*/^{235}\text{U}$ , ( $^{208}\text{Pb}^*/^{232}\text{Th}$ ),  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  and uncertainties together with error correlation.  
*Note:* Explanation or reference to error correlation formula should be given in the footnote or in the main body of the text.
- Calculated age and uncertainty derived from each of: Common Pb corrected<sup>b</sup>  $^{206}\text{Pb}^*/^{238}\text{U}$ ,  $^{207}\text{Pb}^*/^{235}\text{U}$ , ( $^{208}\text{Pb}^*/^{232}\text{Th}$ ),  $^{207}\text{Pb}^*/^{206}\text{Pb}^*$  and uncertainties.
- Optionally, other parameters such as % discordance,  $^{208}\text{Pb}^*/^{206}\text{Pb}^*$  (with uncertainties) or calculated common Pb content may be included, but are not required.  
*Note:* Explanation or reference to % discordance calculation formula should be given in the footnote or in the main body of the text.

---

<sup>a</sup> Th–Pb data should be reported when available.

<sup>b</sup> Where applicable.