

Supp. Mat 1 : U-Pb geochronology

U-Pb geochronology via the in-situ Laser Ablation Inductively Coupled Mass Spectrometer (LA-ICP-MS) method was conducted at the Institut des Sciences Analytiques et de Physico-Chimie pour l'Environnement et les Matériaux (IPREM) laboratory (Pau, France). All the samples (polished chips) were analyzed with a femtosecond laser ablation system (Alfamet, Novalase S.A., France), coupled to an ICP-MS Element XR (ThermoFisher Scientific, Bremen, Germany) fitted with the Jet Interface (Table S1). The aerosol produced by the ablation was carried to the ICP-MS by a tube (1/16" internal diameter) using a Helium stream (600 mL min⁻¹). Measured wash out time of the ablation cell was ~500 ms for helium gas considering the 99% criterion. To improve sensitivity, 10 mL min⁻¹ of nitrogen was added to the twister spray chamber of the ICP-MS via a tangential inlet while helium flow was introduced via another tangential inlet located at the very top of the spray chamber. Measurements were performed under dry plasma conditions. The fs-LA-ICP-MS coupling was tuned on a daily basis in order to achieve the best compromise in terms of sensitivity, accuracy, particles atomization efficiency and stability. The additional Ar carrier gas flow rate, torch position and power were adjusted so that the U/Th ratio was close to 1 +/- 0.05 when ablating the NIST SRM612 glass. Detector cross-calibration and mass bias calibration were checked daily using the appropriate sequence of the Element Software.

The femtosecond laser operates at an IR wavelength of 1030 nm, delivers 360 fs pulses. The laser source can operate within a wide range of repetition rates (1 Hz to 100 kHz) and energy ranging from 200 µJ per pulse below 1 kHz to 1 µJ at 100 kHz. Complex trajectories can be realized by moving the laser beam (15 µm diameter at full energy) across the surface of the sample using the rapid movement of galvanometric scanners combined with a high repetition rate. For in situ U-Pb dating, we have defined a laser trajectory with the

galvanometric scanners (5 mm.s^{-1} speed) allowing to obtain $100 \mu\text{m}$ square ablation craters at a repetition rate of 1 kHz, for 30 s of ablation. Samples were pre-ablated during 3 s with $150 \mu\text{m}$ square craters to remove possible contamination. Final crater depth reached $\sim 160 \mu\text{m}$. The ^{238}U , ^{232}Th , ^{208}Pb , ^{207}Pb , and ^{206}Pb masses were selected, reaching a total mass sweep times of about $\sim 60 \text{ ms}$, before mass sweep averaging (see below). The limits of detection for ^{206}Pb and ^{238}U were ~ 0.3 and $\sim 0.03 \text{ ppb}$, respectively, as calculated by Iolite 4 using the equation of Howell et al. (2010).

U-Pb data from 2 sessions were processed using Iolite 4 software (Paton et al., 2011) and the VizualAge_UcomPbine Data Reduction Scheme for background correction and normalization (Chew et al. 2014). Normalisation used standard sample bracketing to NIST SRM614 glass (Woodhead and Hergt, 2001) for Pb/Pb and Th/U ratios, and WC1 calcite reference material (Age $254.4 \pm 6.4 \text{ Ma}$; Roberts et al., 2017) for Pb/U ratios (WC-1; Roberts et al., 2017), using the method of Roberts et al. (2017) (Fig. S1A). Three (3) NIST and 5 WC1 spots were measured every 20 analyses of the unknown. The Duff Brown Tank limestone (Age 64.04 ± 0.67 ; Hill et al., 2016) was used as validation reference material. No common lead correction nor downhole fractionation correction were made. Due to the low ^{206}Pb and ^{207}Pb concentrations of the unknown samples, the $\sim 60 \text{ ms}$ dwell times used proved too short, and a significant number of sweeps had zero counts on the monitored Pb masses. After background correction, this resulted in large positive or negative spikes in the calculated Pb/Pb and Pb/U ratios using a mean of ratios approach. To avoid such spikes, for samples A16sv and A20 (second session) we used a Python script to average all mass counts over 10 mass sweeps prior to treatment with Iolite, resulting in a final mass sweep value of $\sim 600 \text{ ms}$. For sample A19 (first session), low sensibility of the ICP-MS resulted in low number of counts compared to the second session. Therefore, the average calculated with the Python script comprised 16 mass sweeps, resulting in a final value of $\sim 980 \text{ ms}$. For

consistency across the different samples, this approach was also used for reference materials within a session (e.g., Picazo et al., 2019). A comparison between Pb/Pb and Pb/U ratios obtained for reference materials with and without this initial treatment showed no significant difference.

The uncertainties of the mean isotope ratios of the unknown and validation samples are the standard errors at the 95% level, to which the excess uncertainties, as calculated by Iolite based on the NIST614 reference material, are added (all ratios). Additional systematic uncertainties are propagated onto the final age (Horstwood et al., 2016). These include (2s) decay constant uncertainties (0.1%), an estimate of the long-term reproducibility of the method (2%) and the uncertainty on the reference material age (2.75%; Roberts et al., 2017).

U-Pb ages were determined from lower intercepts on a total-Pb/U–Th isochron plot (Vermeesch, 2020), as recently implemented in the IsoplotR software (Vermeesch, 2018). The additional isotope ratios required by this regression ($^{208}\text{Pb}/^{206}\text{Pb}$, $^{232}\text{Th}/^{238}\text{U}$), as well as the excess variance values added onto sample data were calculated from a Python script relying on the Iolite 4 Python API. Uncertainties are quoted as age \pm x/y, where x is without systematic uncertainties and y is with. The ages obtained for Duff Brown Tank were 66.9 \pm 3.0 Ma and 69.4 \pm 7.6 Ma (2 sessions, 15 spots each, unanchored). When data from the two sessions are pooled together, an age of 67.1 \pm 2.8 Ma is obtained (Fig S1B). All ages are similar to the reference age of 64.0 \pm 0.7 Ma within uncertainties, although centered towards slightly older values. Finally, the recent ages obtained for the three unknown samples (< 6.5 Ma) might be offset from their true value due to initial daughter isotope disequilibrium, in particular excess initial ^{234}U . An initial $^{234}\text{U}/^{238}\text{U}$ activity ratio of \sim 2, which may be common in vein calcite, would shift the calculated ages to values younger by \sim 0.25 Ma (Roberts et al., 2020). Given the \sim 2.5 Ma age difference between the oldest and youngest samples, any excess initial ^{234}U is not expected to change the proposed interpretations.

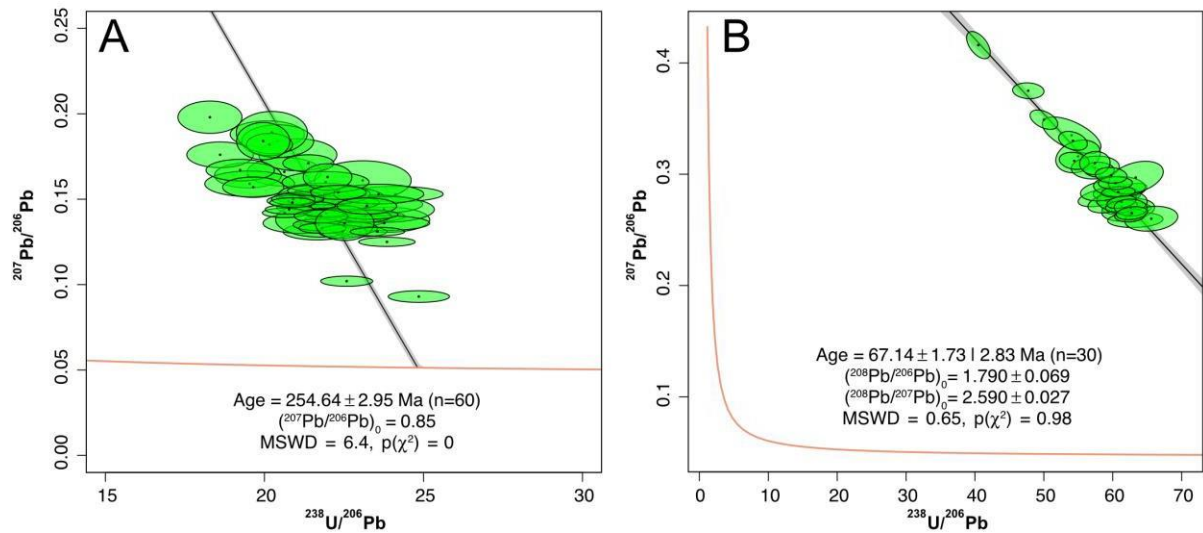


Figure S1: A: Pooled WC1 measurements (Tera-Wasserburg plot) for the 2 sessions. B: Lower intercept age (Total-Pb/U-Th isochron plot) for Duff Brown for the two sessions.

Table S1: Data Reporting Table

Laboratory & Sample Preparation	
Laboratory name	Institut des sciences analytiques et de physico-chimie pour l'environnement et les matériaux (IPREM), UPPA, Pau (France)
Sample type/mineral	Calcite
Sample preparation	In situ in polished blocks
Imaging	Yes, for sample screening
Laser ablation system	
Make, Model & type	Alfamet, Novalase (France)
Ablation cell	Home-made (home-designed) two volumes ablation cell. The large cell has a rectangular shape and a volume of 11.25 cm ³ (75 x 25 x 6 mm size) while the small one, placed above the sample is of 10 mm diameter.
Laser wavelength (nm)	1030 nm
Pulse duration (fs)	360 fs
Fluence (J.cm ⁻²)	5-8 J.cm ⁻² (precleaning 0.5-0.8 J.cm ⁻²)
Repetition rate (Hz)	1 kHz
Gas blank (s)	10 s
Ablation duration (s)	30 s
Washout and/or travel time in between analyses (s)	Wash out time: 500 ms
Spot diameter (μm)	20 μm
Sampling mode / pattern	100 μm craters obtained by laser beam movement across the surface (5 mm/s)
Cell Carrier gas (L/min)	He = 0.600 L/min

ICP-MS Instrument	
Make, Model & type	ICP-MS Thermo Fisher Element2 HR Jet Interface
RF power (W)	1000 - 1100W
Cooling gas flow rate	16 L min ⁻¹
Auxiliary gas flow rate	1 L min ⁻¹
Nebuliser gas flow rate	0.5 L min ⁻¹
Masses measured	206, 207, 208, 232, 238
Samples per peak	30
Mass window	10 %
Sample time	3 ms
Settling time	1 ms
Mass sweep	60 ms
Averaged mass sweep	16 (session 1), 10 (session 2)
Resolution	300
Sensitivity	Percentage of ions detected with regard to atoms ablated is ~0.004 to ~0.02% for U, as calculated with NIST 612
Data Processing	
Calibration strategy	NIST614 as primary reference material for Pb-Pb, Th-U and Pb-U ratios, WC-1 carbonate standard for matrix matching of ²⁰⁶ Pb/ ²³⁸ U, Duff Brown carbonate for validation
Reference Material info	Primary: NIST614 – Pb-Pb ratios: Woodhead and Hergt (2001); Th-U and Pb-U ratios: calculated from Duffin et al. (2012), Jochum et al. (2011) and CIAAW-IUPAC. WC-1 254.4 ± 6.4 Ma (2s) - Roberts et al. (2017) Validation: Duff Brown (DBT) 64.04 +/- 0.67 Ma (2s) - Hill et al. (2016)
Data processing package used / Correction for LIEF	Element XR acquisition software, data processing with Iolite 4 and Python code.
Common-Pb correction, composition and uncertainty	No common Pb correction. Unanchored robust regressions in total-Pb/U-Th isochron plot (Vermeesch, 2020). Ages in the figures are quoted at 95% absolute uncertainties and include systematic uncertainties, propagation is by quadratic addition.
Quality control / Validation	2 analyses of Duff Brown (unanchored) gave ages 66.9 ± 3.0 Ma and 69.4 ± 7.6 Ma. Pooled data gave 67.1 ± 2.8 Ma.

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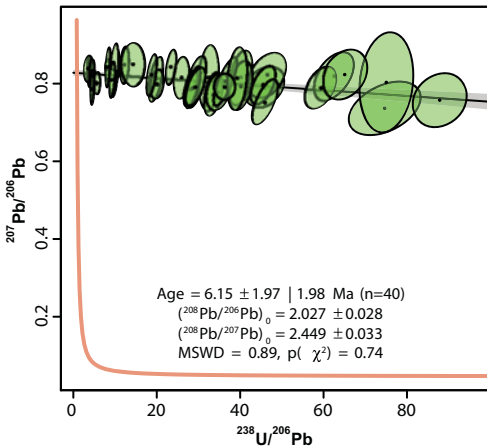
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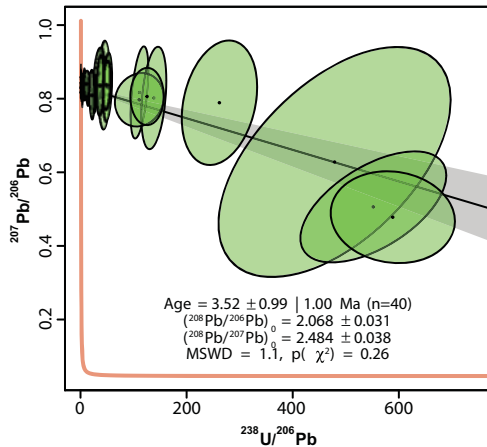
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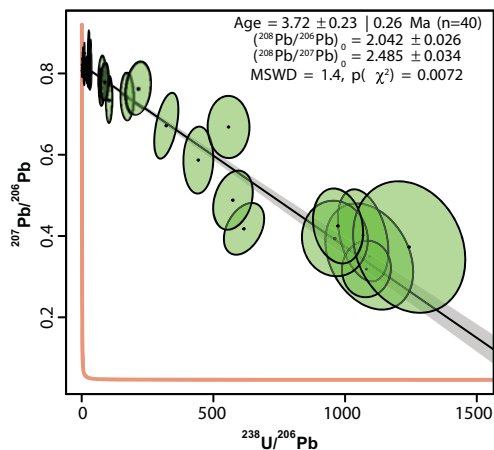
Supp Mat 2 : Tera-Wasserburg diagrams from veins from San Vicino anticline



Sample A016
(set I vein-LPS)



Sample A019
(set II vein-folding)



Sample A020
(set III vein-LSFT)

Supp Mat 3 : Information about dated veins from San Vicino anticline

Sample ID	Formation	Bedding (Dipdir/dip)	Vein orientation (Dipdir/dip)		Deformation stage	GPS	Location (decimal degrees)	
			Current	Corrected			Longitude	Latitude
A16	Maiolica	040/15	300/70	116/88	LPS	102	13.080519977957	43.3567029889673
A19	Maiolica	050/32	222/64	045/88	FOLDING	104	13.0812089703977	43.3549599722028
A20	Maiolica	050/32	127/90	131/72	LSFT	104	13.0812089703977	43.3549599722028

