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DATA REPOSITORY

Detailed methods

Laser-Raman spectroscopy (RS) has been performed on the samples to estimate pressure and temperature independently. The degree of graphitization of carbonaceous material during metamorphism depends on temperature and is irreversible, which provides a good thermometer to estimate maximum temperatures (e.g., Beyssac et al., 2002). The applicable range of temperatures (330-650 °C) allows us to use this method for our study and its accuracy has been estimated to be \pm 50°C (Beyssac et al., 2002). Quartz stressed at depth due to the confining pressure, then entrapped in growing garnet will hold - in principle - the pressure acting at the time of entrapment. This result in a shift of the 464 peak (Δv 464) of quartz. Depending on the structure related to the composition of the host garnet, the quartz inclusion will tend to relax this stress to variable degree (Rosenfeld, 1969; Enami et al., 2007). For this reason, only the highest entrapment pressure estimate must be considered for each sample. Additionally, the composition of the host garnet has to be measured in order to estimate the pressure. We used Raman spectroscopy to obtain spectra of quartz inclusions in garnets and pressure was determined using the Quiblab program described and created by Ashley et al. (2014). Temperature estimates were performed at École Normale Supérieure, Paris, France using a Renishaw *in Via* equipped with an Ar ion laser (514.5 nm wavelength). Pressure estimates were done at Freie Universität Berlin, Germany using a Horiba ISA Dilor Labram equipped with a Nd-YAG laser (532 nm wavelength). Both Raman spectrometers were equipped with a CCD detector and laser spot size was focused to 1 μ m through a microscope (x100 objective) on the material of interest. Conditions used were a grating of 1800 grooves/mm and hole of 400 µm, with full intensity of the laser to analyze quartz and 50% of the intensity for carbonaceous material. For quartz and other minerals e.g. garnets spectra measurements, we took an acquisition time over 30-90 s and spectra centered on the 1000 cm⁻¹. For carbonaceous material, we measured with acquisition time over 10 s with 5 accumulation and spectra centered on 1450 cm⁻¹, to obtain all the bands of the carbonaceous material. Calibration was done on Si standard with a 520 nm peak in both cases. To ensure good determination of quartz peak, an additional quartz standard (464 peak) was used and both standards were measured several times during the day to correct for potential peak shift with time. To smooth structural heterogeneity of the CM, 15-20 spectra were measured for each

sample to estimate the maximum temperature. The fitting of the spectra obtained with Raman spectroscopy was done using a Voigt function with the program PeakFit 3.0 (Jandel Scientific). For further processing, we extracted from PeakFit the peak position of quartz and peak position and band area for carbonaceous material.

Zr content in rutile increases with temperature (Zack et al., 2004). This thermometer allows broad applications since it is suitable for various rock types and a large range of temperatures (430-1100 °C; Zack et al, 2004). Even though the absolute uncertainty is estimated to be \pm 50 °C due to the use of natural samples, the precision of the rutile thermometer is estimated to be \pm 10 °C (high reproducibility; Zack et al, 2004). Concentrations of Zr in rutile were determined by EPMA performed on a JEOL JXA 8900 Superprobe electron microprobe at the Institute for Mineralogy of the Westfälische Wilhelms-Universität Münster, equipped with five wavelength-dispersive spectrometers (WDS). Operating conditions were 15 kV accelerating voltage, 120 nA beam current and a beam diameter of 3 µm. To achieve low detection limits (35 ppm) of Zr, peak count rate times were 30 s and 15 s for background for Zr. To avoid boundary effects, we measured rutiles with a size > 10 µm and used the quality control after Zack et al. (2004), by measuring the Si concentration. However, we considered a slightly higher limit for the Si content of 250 ppm. To estimate the temperature, we used the equation of Ferry and Watson (2007), using a new calibration over a broader range of temperatures (470 –1.400 °C).

Sample	Sample locality		T Zr in rutile (T _{Zr})	T Carbonaceous	P Qtz in	P from	P used
number	Latitude	Longitude	± std Material (T _c) ± sto		Gt (P _R)	coesite	for map
	(°N)	(°E)	(°C)	(°C)	(GPa)		
AK 14.04	42.5136	81.3133	N.D.*	N.D.	2.38	N.A.†	2.38
AK 14.06	42.4992	81.3136	N.D.	540 ± 24	N.D.	N.A.	N.D.
AK 14.10	42.5069	81.3192	N.D.	573 ± 29	N.D.	N.A.	N.D.
AK 14.13	42.5136	81.3197	N.D.	536 ± 25	N.D.	N.A.	N.D.
AK 14.14	42.5147	81.3200	N.D.	537 ± 21	N.D.	N.A.	N.D.
AK 14.19	42.5203	81.3169	N.D.	525 ± 20	N.D.	N.A.	N.D.
AK 14.30	42.4942	81.3044	530 ± 22	N.D.	N.D.	N.A.	N.D.
AK 14.31	42.4964	81.3028	N.D.	530 ± 15	N.D.	N.A.	N.D.
AK 14.35	42.5039	81.3014	528 ± 18	N.D.	2.34	N.A.	2.34
AK 14.46	42.5289	81.3100	N.D.	539 ± 24	N.D.	N.A.	N.D.
AK 14.47	42.5294	81.3094	520 ± 20	546 ± 32	2.56	2.70	2.70
AK 14.50	42.5253	81.3006	N.D.	524 ± 32	N.D.	N.A.	N.D.
AK 14.61	42.5378	81.3014	N.D.	530 ± 18	N.D.	N.A.	N.D.
AK 14.63	42.5428	81.3067	N.D.	534 ± 22	N.D.	N.A.	N.D.
AK 14.65	42.5436	81.3036	N.D.	531 ± 19	N.D.	N.A.	N.D.
AK 14.66	42.5503	81.3008	532 ± 15	N.D.	1.86	2.70	2.70
AK 15.04	42.5125	81.3136	534 ± 32	N.D.	1.51	2.70	2.70
AK 15.07	42.4911	81.3203	N.D.	546 ± 25	N.D.	N.A.	N.D.
AK 15.08	42.4889	81.3228	N.D.	N.D.	2.06	N.A.	2.06
AT 14.05	42.4914	81.2689	522 ± 17	N.D.	2.79	N.A.	2.79
AT 14.17	42.5078	81.2581	N.D.	546 ± 10	N.D.	N.A.	N.D.
AT 14.22	42.5083	81.2669	N.D.	N.D.	2.30	N.A.	2.30
AT 14.25	42.4658	81.2539	N.D.	N.D.	2.33	N.A.	2.33
AT 14.27	42.4653	81.2531	N.D.	544 ± 14	N.D.	N.A.	N.D.
AT 14.30	42.4683	81.2542	N.D.	509 ± 20	2.60	N.A.	2.60
AT 14.32	42.4758	81.2650	525 ± 22	537 ± 18	2.48	N.A.	2.48
AT 14.37	42.5161	81.2553	543 ± 14	553 ± 26	2.30	N.A.	2.30
AT 14.39	42.5233	81.2292	N.D.	N.D.	2.74	N.A.	2.74
AT 14.41	42.5294	81.2181	N.D.	546 ± 19	2.81	2.70	2.81
AT 14.42	42.5319	81.2075	529 ± 22	553 ± 20	2.62	2.70	2.70
M 14.02	42.5383	81.2658	537 ± 21	N.D.	1.87	2.70	2.70
M 14.06	42.5442	81.2522	N.D.	535 ± 30	N.D.	N.A.	N.D.
Average			530 ± 7	537 ± 13	2.35		2.54

TABLE DR1. SAMPLE NUMBER, LOCALISATION, TEMPERATURE AND PRESSURE ESTIMATES

Note: The error for pressure estimates is of +-0.2 for all samples, considering intrumental and fitting errors

*N.D. = not determined

†N.A. = not applicable

Measurement I	ocality	Schisto	osity	Lineation		
Latitude (°N)	Longitude (°E)	S dip azimut	S dip	L trend	L plunge	
42.5203	81.3169	320	55	339	39	
42.5136	81.3197	255	72			
42.5008	81.3161	282	86			
42.4919	81.3044	340	25	340	32	
42.4964	81.3028	355	51			
42.5014	81.3017	341	75			
42.5244	81.3131	316	74			
42.5172	81.2833	310	55	350	48	
42.5294	81.2942	336	38	10	33	
42.5344	81.3031	320	43	10	31	
42.5428	81.3056	351	49	351	49	
42.5514	81.3008	120	25			
42.4925	81.2869	20	50	5	49	
42.4947	81.2800	0	50			
42.5083	81.2469	346	21	3	20	
42.5075	81.2628	15	60	5	60	
42.4806	81.2511	94	48	61	43	
42.4681	81.2542	10	50	30	48	
42.4739	81.2639	28	52			
42.5194	81.2433	15	54	335	47	
42.5161	81.2553	49	31	348	16	
42.5233	81.2294	4	36	352	35	
42.5294	81.2181	266	34	330	17	
42.5319	81.2075	21	41	356	38	
42.5264	81.2875	12	41	21	41	
42.5394	81.2658	339	42	12	37	
42.5425	81.2531	23	42	14	42	
42.5461	81.2480	338	61			
42.5491	81.2473	336	49			
42.5544	81.2466	152	57			
42.5114	81.3073	70	60			
42.5017	81.2895	338	45	340	45	
42.4918	81.3196	348	26	8	25	
42.4885	81.3255	291	83			
42.5405	81.2889	22	37			
42.5500	81.2875	321	61	340	60	
42.5545	81.2866	339	83			
42.5655	81.3012	161	42			
42.5626	81.3074	177	67			
42.4810	81.2617	340	80			
42.4887	81.2603	32	45			
42.5340	81.2005	320	78			
42.5370	81,1964	312	80			

TABLE DR3. P-T DATA FROM LITERATURE AND METHOD USED TO CONSTRAIN P & T							
Literature	Т	Р	Method for P-T estimates				
	(°C)	(GPa)	* CGTP	Other	Pseudosection model / system		
Gao & Klemd, 2000	480-580	1.4-2.1	EG, H80	based on mineral assemblage			
Klemd et al., 2002	450-530	1.8-2.2	W96, WM				
Wei et al., 2003	540-550 560 580	1.6 1.5-1.7 1.5-1.9		TC_std_HP98	THERMOCALC / std		
John et al., 2008	530-560	1.9	EG, P85				
VanDerStraaten, 2008	575-635 625-655	1.85-2.05	EG, P85		Perple_X / std		
Lü et al., 2008	570-630	2.7-3.3	RT, P85, WM				
Wei et al., 2009	550-570 550 540-550	3.2 2.25 2.2-2.3			THERMOCALC / MnK-std		
Lu et al., 2009	420-520 470-510	2.7 2.4-2.7	R00		† Domino / Theriak / std		
Beinlich et al., 2010	480-540	1.95-2.25			Perple_X / TiK-std		
Klemd et al., 2011	500-580 540-600	1.6-2.0 2.0-2.4	R00, W96				
Lü et al., 2012 b	540–580	2.7		§ Zr in Rtl, presence of coesite			
Li et al., 2013	590	2.3			Perple_X / MnK-std		
Tian-Wei. <i>,</i> 2013	526–540 518 590 540	2.9–3.0 2.82 2.4-2.7 2.2			THERMOCALC / MnK-std		
Yang et al., 2013	565	2.9			THERMOCALC / MnK-std		
Du et al., 2014	460–590	2.4–2.7			THERMOCALC / MnK-std		
Meyer et al., 2016	540-550 555-575	1.9-2.25 2.2-2.5		# RSCM and Average P-T (THERMOCALC)			
Soldner et al., 2016	425-500	2.5-2.6			Perple_X / MnK-std		
Tan et al., 2017	490-530 520-560	2.93-2.97 2.43-2.47		Average P-T (THERMOCALC)	THERMOCALC / MnK-std		

* CGTP = conventionnal geothermo-barometry, abbreviations for the different methods: EG : Ellis & Green, 1979 ; H80 : Holland, 1980 ; P85 : Powell, 1985 ; WM : Waters-Martin, 1993 ; R00 : Ravna, 2000 ; W96 : Waters, 1996 ; RT : Ravna & Terry, 2004

All pseudosection calculationS with Perple_X (Connolly, 1990) and THERMOCALC were made with the database of Holland and Powell (1998). Std: system NCFMASH; MnK-std: MnKNCFMASH; TiK-std: TiKNCFMASH

§ Zr in Rtl = Zr in rutile thermometry, using the equation of Tomkins et al. (2007)

RSCM = Raman spectrscopy on carbonaceous material thermometry

+ Domino / Theriak = Pseudosection calculated with Domino / Theriak (de Capitani & Brown, 1987), using the database of Berman (1988)



Figure DR1: Compilation of P-T estimates from the literature (Table DR2) and from this study. Note the very scattered P-T estimates results from previous studies.

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