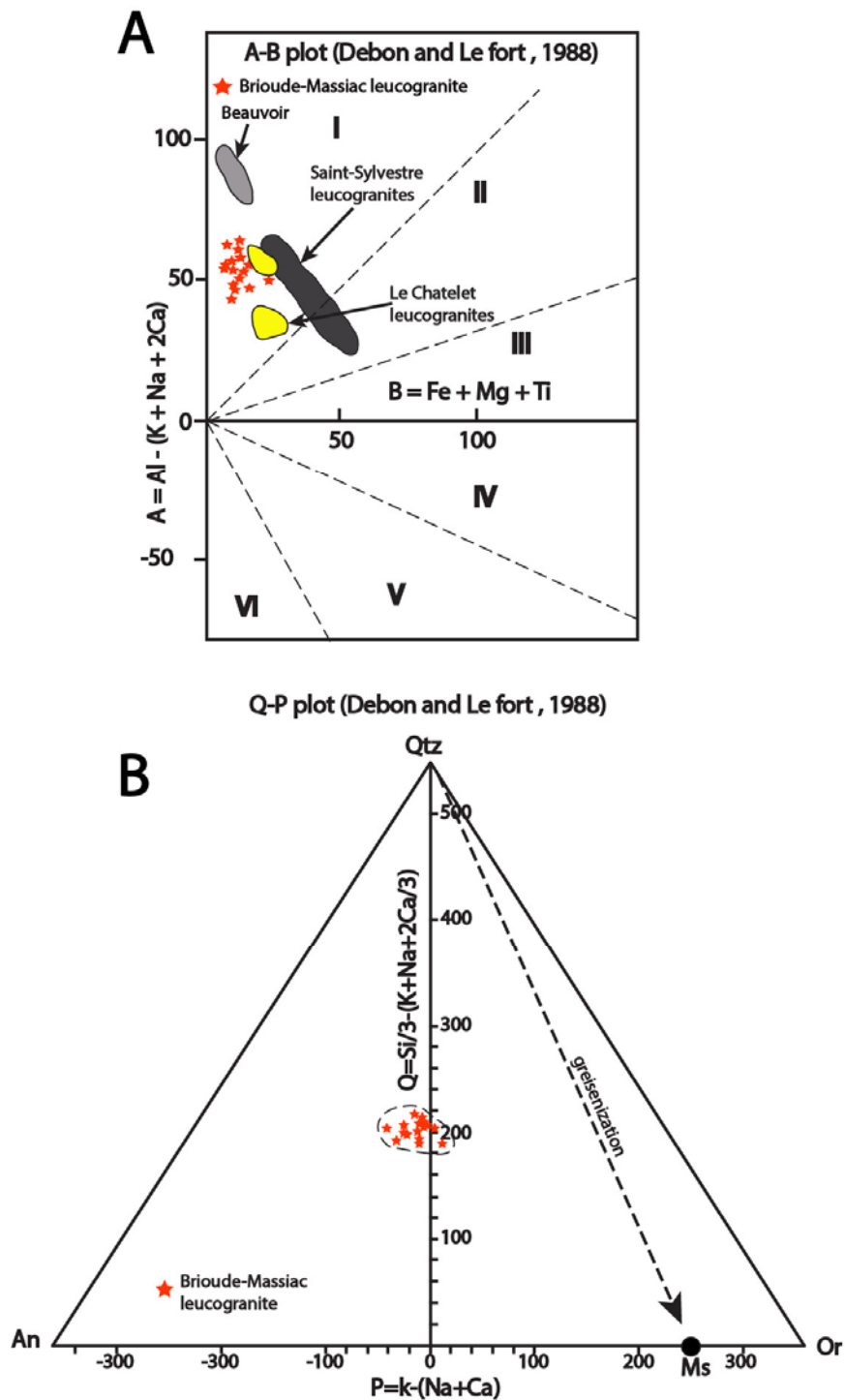


Supplementary data

ESM 1

Geochemical compositions of the Brioude-Massiac leucogranitic dykes replaced in the A) A-B plot, and B) Q-P plot from Debon and Le fort (1988) diagrams. Data from Sandras (1988).



ESM 2

Electron microprobe analyses of arsenopyrite and the gold grain from the Bonnac veins.

Arsénoxyrites		Weight%							Det.Lim ppm							Atomic%				
Localisation	Commentaires	S	Sb	Fe	As	Au	Total	S	Sb	Fe	As	Au	S	Sb	Fe	As	Au	Total		
Bonnac	BM29A_Asp1_coeur2	18.85	bdl	34.45	45.92	bdl	99.22	336	592	317	881	953	32.34	0.00	33.93	33.72	0.00	100		
Bonnac	BM29A_Asp2_coeur	18.92	0.09	34.23	46.14	bdl	99.38	367	606	316	876	-	32.43	0.04	33.68	33.84	0.00	100		
Bonnac	BM29A_Asp2_bord	18.65	bdl	34.19	46.79	bdl	99.63	364	596	311	885	-	31.99	0.00	33.67	34.34	0.00	100		
Bonnac	BM29A_Asp3_C	19.00	0.09	34.58	46.44	bdl	100.11	390	605	323	882	-	32.34	0.04	33.79	33.83	0.00	100		
Bonnac	BM29A_Asp3_B	19.38	bdl	34.62	45.88	bdl	99.87	363	-	311	876	-	32.91	0.00	33.75	33.34	0.00	100		
Bonnac	BM29A_Asp4_C	19.19	bdl	34.13	45.96	bdl	99.27	389	599	318	880	-	32.83	0.00	33.52	33.65	0.00	100		
Bonnac	BM29A_Asp5_B	19.17	bdl	34.27	46.36	bdl	99.79	374	602	317	882	-	32.67	0.00	33.52	33.81	0.00	100		
Bonnac	BM29A_Asp5_C	18.96	bdl	34.25	46.38	bdl	99.59	364	596	314	881	-	32.43	0.00	33.63	33.94	0.00	100		
Bonnac	BM29A_Asp6_C	19.14	bdl	34.66	46.16	bdl	99.96	380	597	313	887	-	32.55	0.00	33.85	33.60	0.00	100		
Bonnac	BM29A_Asp6_C2	19.39	bdl	34.85	45.99	bdl	100.22	367	596	316	868	-	32.82	0.00	33.87	33.31	0.00	100		
Bonnac	BM29A_Asp7_C	19.27	bdl	34.61	45.69	bdl	99.56	351	591	321	891	959	32.83	0.00	33.85	33.31	0.00	100		
Bonnac	BM29A_Asp8_C	18.85	0.11	34.31	45.94	bdl	99.22	362	593	319	880	-	32.37	0.05	33.82	33.76	0.00	100		
Bonnac	BM29A_Asp9_C	19.30	bdl	34.49	45.70	bdl	99.49	363	-	323	872	-	32.91	0.00	33.75	33.34	0.00	100		
Bonnac	BM29A_Asp10_C	19.05	bdl	34.44	45.65	bdl	99.14	344	595	319	885	-	32.65	0.00	33.88	33.47	0.00	100		
Bonnac	BM29A_Asp11_C	19.22	bdl	34.32	45.96	bdl	99.50	359	588	320	879	964	32.81	0.00	33.62	33.57	0.00	100		
Bonnac	BM29A_Asp12_C	19.30	bdl	34.54	45.78	bdl	99.62	338	577	317	886	959	32.87	0.00	33.77	33.36	0.00	100		
Bonnac	BM29A_Asp13_C	19.48	bdl	34.61	45.63	bdl	99.72	317	598	321	884	-	33.09	0.00	33.74	33.17	0.00	100		
Bonnac	BM29A_Asp13_B	18.86	bdl	34.04	46.29	bdl	99.19	388	583	321	874	-	32.40	0.00	33.57	34.03	0.00	100		
Bonnac	BM29A_Asp13_B2	20.10	bdl	34.49	44.91	bdl	99.49	396	597	317	867	-	34.00	0.00	33.49	32.51	0.00	100		
Bonnac	BM29A_Asp14_C	19.41	bdl	34.42	45.69	bdl	99.52	372	597	314	872	-	33.06	0.00	33.64	33.30	0.00	100		
Bonnac	BM29A_Asp15_B	19.16	bdl	34.34	46.29	bdl	99.79	389	602	317	874	-	32.64	0.00	33.60	33.76	0.00	100		
Bonnac	BM29A_Asp16_C	18.88	bdl	34.26	46.28	bdl	99.42	359	584	320	875	-	32.35	0.00	33.71	33.94	0.00	100		
Bonnac	BM29A_Asp16_B	19.00	bdl	33.37	45.21	bdl	97.59	347	588	314	883	-	33.05	0.00	33.31	33.64	0.00	100		
Bonnac	BM29A_Asp17_C	19.02	bdl	34.27	46.04	bdl	99.32	358	-	314	880	-	32.57	0.00	33.69	33.74	0.00	100		
Bonnac	BM29A_Asp18_C	19.28	bdl	34.56	45.91	bdl	99.75	366	594	322	875	956	32.80	0.00	33.77	33.43	0.00	100		
Bonnac	BM29A_Asp18_B	19.99	bdl	34.37	44.25	bdl	98.61	379	586	314	868	-	34.08	0.00	33.64	32.28	0.00	100		
Bonnac	BM29A_Asp19_C	19.57	bdl	34.55	45.19	0.13	99.44	364	585	319	876	959	33.30	0.00	33.75	32.91	0.04	100		
Bonnac	BM29A_Asp20_C	19.24	bdl	34.19	45.78	bdl	99.21	379	585	318	869	-	32.92	0.00	33.57	33.51	0.00	100		
Bonnac	BM29A_Asp21_C	19.21	bdl	34.37	45.94	bdl	99.51	380	-	311	881	-	32.79	0.00	33.67	33.55	0.00	100		
Bonnac	BM29A_Asp22_C	19.84	bdl	34.47	44.46	bdl	98.76	376	584	316	861	-	33.83	0.00	33.74	32.44	0.00	100		
Bonnac	BM29A_Asp23_C	19.24	bdl	34.36	45.80	bdl	99.40	388	597	314	870	-	32.85	0.00	33.68	33.47	0.00	100		
Bonnac	BM29A_Asp23_B	19.89	bdl	34.32	45.19	bdl	99.40	397	-	311	875	957	33.76	0.00	33.43	32.81	0.00	100		
Bonnac	BM29A_Asp24_B	19.11	bdl	34.34	46.04	bdl	99.48	388	-	322	879	958	32.65	0.00	33.68	33.67	0.00	100		
Bonnac	BM29A_Asp25_C	19.28	0.15	34.39	45.88	bdl	99.69	367	600	316	870	-	32.84	0.07	33.63	33.45	0.00	100		
Bonnac	BM29A_Asp25_C2	19.43	bdl	34.58	45.80	bdl	99.80	389	579	317	870	-	33.00	0.00	33.71	33.29	0.00	100		
Bonnac	BM29A_Asp25_B	19.54	bdl	34.63	45.59	bdl	99.75	369	576	318	873	-	33.16	0.00	33.74	33.11	0.00	100		
Bonnac	BM29A_Asp26_C	19.04	bdl	34.42	46.08	bdl	99.54	374	603	318	875	959	32.53	0.00	33.77	33.70	0.00	100		
Bonnac	BM29A_Asp27_C	19.47	0.11	34.47	45.52	bdl	99.56	365	592	319	880	-	33.13	0.05	33.67	33.15	0.00	100		
Bonnac	BM29A_Asp28_C	19.82	bdl	34.54	45.34	bdl	99.70	355	608	318	880	956	33.56	0.00	33.58	32.86	0.00	100		
Bonnac	BM29A_Asp28_B	19.17	bdl	34.59	46.09	bdl	99.84	393	-	315	873	-	32.63	0.00	33.80	33.57	0.00	100		
Bonnac	BM29A_Asp29_C	18.71	bdl	34.09	46.69	bdl	99.50	367	579	314	876	-	32.12	0.00	33.59	34.29	0.00	100		
Bonnac	BM29A_Asp_30C	19.21	bdl	34.34	45.66	bdl	99.21	352	-	322	858	-	32.86	0.00	33.72	33.42	0.00	100		
Bonnac	BM29A_Asp_30B	19.88	bdl	34.57	44.95	bdl	99.40	359	-	316	868	-	33.71	0.00	33.66	32.63	0.00	100		
Bonnac	BM29A_Asp_31C	19.28	bdl	34.23	45.54	0.15	99.19	361	594	314	867	952	32.99	0.00	33.63	33.34	0.04	100		
Bonnac	BM29A_Asp_31B	19.16	bdl	34.19	45.48	bdl	98.83	364	583	322	871	963	32.89	0.00	33.70	33.41	0.00	100		
Bonnac	BM29A_Asp_32C	19.12	bdl	34.48	46.36	bdl	99.96	363	592	316	873	-	32.55	0.00	33.69	33.76	0.00	100		
Bonnac	BM29A_Asp_32B	19.88	bdl	34.45	45.10	bdl	99.43	373	579	316	875	-	33.72	0.00	33.55	32.74	0.00	100		
Bonnac	BM29A_Asp_33C	19.23	bdl	34.27	45.47	bdl	98.98	361	-	321	887	970	32.95	0.00	33.71	33.34	0.00	100		
Bonnac	BM29A_Asp_34C	19.02	bdl	34.16	46.26	bdl	99.44	407	-	319	880	950	32.56	0.00	33.56	33.88	0.00	100		
Bonnac	BM29A_Asp_35C	19.11	bdl	34.62	46.17	bdl	99.90	366	-	321	879	959	32.54	0.00	33.83	33.63	0.00	100		
Bonnac	BM29A_Asp_36C	19.21	bdl	34.48	45.83	bdl	99.52	334	-	322	863	959	32.77	0.00	33.77	33.46	0.00	100		
Bonnac	BM29A_Asp_37C	20.11	bdl	34.49	44.74	bdl	99.34	377	-	313	870	955	34.05	0.00	33.53	32.42	0.00	100		
Bonnac	BM29A_Asp_37B	18.84	bdl	34.01	46.40	bdl	99.24	378	595	322	877	-	32.36	0.00	33.53	34.11	0.00	100		
Bonnac	BM29A_Asp_38B	18.85	bdl	34.06	46.43	bdl	99.34	380	593	316	871	-	32.35	0.00	33.55	34.10	0.00	100		
Bonnac	BM29A_Asp_38C	19.43	bdl	34.40	45.52	bdl	99.34	367	597	304	883	-	33.12	0.00	33.67	33.21	0.00	100		
Bonnac	BM29A_Asp_39C	18.52	bdl	34.04	46.76	bdl	99.32	363	593	316	883	-	31.89	0.00	33.65	34.45	0.00	100		

Grains d'or		Weight%					Det.Lim ppm				
Localisation	Commentaires	Ag	Au	Hg	Sb	Total	Ag	Au	Hg	Sb	Total
Bonnac	Or dans Py/Ccp	16.07	84.57	bdl	bdl	100.64	696	2284	-	-	-
Bonnac	Or dans Py/Ccp	11.05	89.77	bdl	bdl	100.82	692	2307	-	-	-
Bonnac	Or dans Py/Ccp	8.81	92.37	bdl	bdl	101.18	584	1975	-	1190	-
Bonnac	Or dans Py/Ccp	7.85	91.86	bdl	bdl	99.71	552	1936	-	-	-
Bonnac	Or dans Py/Ccp	17.18	83.07	bdl	bdl	100.26	609	1971	-	1216	-
Bonnac	Or dans Py/Ccp	19.63	77.84	0.29	bdl	97.77	594	1985	1136	-	-
Bonnac	Or dans Py/Ccp	20.05	78.97	bdl	bdl	99.02	598	1967	1131	-	-
Bonnac	Or inclus dans Ccp+Bi	19.68	79.53	bdl	bdl	99.21	589	1977	-	1174	-
Bonnac	Or inclus dans Ccp+Bi	22.14	76.34	bdl	bdl	98.48	594	1968	-	1213	-
Bonnac	Or inclus dans Asp	24.51	72.12	0.42	bdl	97.04	613	1964	1121	1175	-

ESM 3

Operating conditions for the LA-ICP-MS equipment and LA-ICP-MS U/Pb analyses for the apatites from the studied samples.

Laboratory & Sample Preparation	
Laboratory name	Géosciences Rennes, UMR CNRS 6118, Rennes, France
Sample type/mineral	apatite
Sample preparation	Thin and polished sections
Imaging	MEB Merlin Compact Zeiss with EDS detector EDS (Bruker, Quantax – Xflash6– 129 eV)
Laser ablation system	
Make, Model & type	ESI NWR193UC, Excimer
Ablation cell	ESI NWR TwoVol2
Laser wavelength	193 nm
Pulse width	< 5 ns
Fluence	6.5 J/cm ²
Repetition rate	5 Hz
Spot sizes	40 µm (round spot)
Sampling mode / pattern	Single spot
Carrier gas	100% He, Ar make-up gas and N2 (3 ml/mn) combined using in-house smoothing device
Background collection	20 seconds
Ablation duration	60 seconds
Wash-out delay	15 seconds
Cell carrier gas flow (He)	0.75 l/min
ICP-MS Instrument	
Make, Model & type	Agilent 7700x, Q-ICP-MS
Sample introduction	Via conventional tubing
RF power	1350W
Sampler, skimmer cones	Ni
Extraction lenses	X type
Make-up gas flow (Ar)	0.87 l/min
Detection system	Single collector secondary electron multiplier
Data acquisition protocol	Time-resolved analysis
Scanning mode	Peak hopping, one point per peak
Detector mode	Pulse counting, dead time correction applied, and analog mode when signal intensity > ~ 10 ⁶ cps
Masses measured	⁴³ Ca, ²⁰⁴ Hg + Pb, ²⁰⁶ Pb, ²⁰⁷ Pb, ²⁰⁸ Pb, ²³² Th, ²³⁸ U
Integration time per peak	10-30 ms
Sensitivity / Efficiency	28 000 cps/ppm Pb (50µm, 10Hz)
Dwell time per isotope	5-70 ms depending on the masses
Data Processing	
Gas blank	20 s on-peak
Calibration strategy	Madagascar apatite used as primary reference material, Durango and McClure apatite standards used as secondary reference material (quality control)
Reference Material info	Madagascar (Thomson et al., 2012) Durango (McDowell et al., 2005) McClure (Schoene and Bowring, 2006)
Data processing package used	Iolite (Paton et al., 2010), VizualAge_UcomPbine (Chew et al., 2014)
Quality control / Validation	Durango: Weighted average ²⁰⁷ Pb corrected age = 31.89 ± 0.70 Ma (MSWD = 0.62) McClure: Weighted average ²⁰⁷ Pb corrected age = 526 ± 14 Ma (MSWD = 1.7)

		U (ppm)	Pb (ppm)	238U/206Pb	Error (2σ)	207Pb/206Pb	Error (2σ)	Final 207 Age	Error (2σ)
	BM46d_1	111.90	7.82	15.830	0.250	0.2212	0.0054	317	16
	BM46d_2	122.60	7.77	16.130	0.220	0.2083	0.0030	316	14
	BM46d_3	115.90	8.24	15.530	0.220	0.2283	0.0053	317	13
	BM46d_4	88.40	8.02	14.510	0.130	0.2680	0.0031	318	17
	BM46d_5	127.60	10.31	15.700	0.130	0.2254	0.0024	316	17
	BM46d_7	66.10	7.61	13.350	0.130	0.3069	0.0044	324	19
	BM46d_8	73.70	7.89	13.620	0.180	0.2896	0.0054	327	16
	BM46d_9	176.80	10.11	16.340	0.230	0.1849	0.0039	324	17
	BM46d_10	64.44	7.24	13.640	0.120	0.2992	0.0037	322	18
	BM46d_11	148.70	10.11	15.750	0.190	0.2071	0.0027	324	16
	BM46d_13	66.79	10.16	11.660	0.140	0.3781	0.0048	323	22
	BM46d_14	158.30	13.75	14.540	0.120	0.2616	0.0031	322	16
	BM46d_15	90.33	14.57	11.950	0.130	0.3472	0.0039	336	21
	BM46d_16	97.10	10.38	13.500	0.200	0.3023	0.0110	322	21
	BM46d_17	41.64	21.18	5.768	0.096	0.6060	0.0063	344	43
	BM46d_18	39.08	40.03	3.384	0.055	0.7010	0.0070	369	63
	BM46d_19	51.83	12.96	9.000	0.160	0.4660	0.0077	343	30
	BM46d_20	51.96	39.50	4.255	0.091	0.6550	0.0077	377	44
	BM46d_21	38.60	33.40	3.870	0.130	0.6810	0.0066	362	40
	BM46d_22	207.80	17.13	14.780	0.200	0.2421	0.0078	327	16
	BM46d_23	204.30	22.95	13.660	0.160	0.3051	0.0062	317	11
Ferbert vein	BM46d_24	68.00	32.18	6.160	0.100	0.5915	0.0075	341	20
Bonnac	BM39a_2	29.06	3.39	12.930	0.150	0.3233	0.0063	324	14
	BM39a_3	30.09	3.58	12.970	0.180	0.3140	0.0110	333	13
	BM39a_4	26.70	2.79	13.030	0.170	0.2997	0.0074	336	16
	BM39a_5	24.32	2.65	13.500	0.280	0.3000	0.0120	325	22
	BM39a_6	11.66	2.86	9.440	0.160	0.4710	0.0085	323	28
	BM39a_7	13.39	3.39	9.730	0.150	0.4550	0.0083	326	23
	BM39a_8	13.13	3.52	9.510	0.140	0.4573	0.0075	333	25
	BM39a_9	13.53	2.97	10.730	0.340	0.4260	0.0090	321	29
	BM39a_10	11.25	3.02	9.240	0.130	0.4747	0.0140	326	24
	BM39a_11	23.39	3.31	12.420	0.180	0.3438	0.0077	324	16
	BM39a_13	138.10	5.24	16.830	0.150	0.1567	0.0027	325	11
	BM39a_14	76.90	5.10	15.340	0.240	0.2360	0.0047	319	12
	BM39a_15	315.50	6.81	17.830	0.220	0.1208	0.0026	324	12
	BM39a_16	79.80	5.17	15.220	0.260	0.2271	0.0045	325	13
	BM39a_17	76.51	4.93	15.650	0.150	0.2160	0.0027	320	12
	BM39a_19	243.20	5.29	17.940	0.160	0.1138	0.0027	324	11
	BM39a_21	34.74	3.53	13.280	0.160	0.2944	0.0052	332	16
	BM39a_24	48.50	4.04	14.260	0.200	0.2660	0.0052	326	15