UTM coordinates of samples

Sample	UTM coordinates	
PLB-	X	Y
71	656571	4202532
73	656937	4201969
74	657683	4201284
76	657817	4200264
77	658462	4197940
79	658244	4194716
80	657370	4194128
81	657412	4191653
82	657768	4189514
84 (map 2)	657448	4186921
85	658363	4185606
86	669833	4186562
87	669676	4187664
88 (map 1)	669708	4187924
89	669869	4188826
91	674526	4196530
93 (map 3)	674985	4196974
7C	669881	4188776

Chlorite thermometry

The approach of Vidal et al. (2005 and 2006) is based on five chlorite end-members, which are Mg-amesite ($Al_2Mg_4[Al_2Si_2]O_{10}(OH)_8$), Fe-amesite ($Al_2Fe_4[Al_2Si_2]O_{10}(OH)_8$), daphnite ($AlFe_5[AlSi_3]O_{10}(OH)_8$), clinochlore ($AlMg_5[AlSi_3]O_{10}(OH)_8$) and sudoite ($Al_3Mg_2\square_1[AlSi_3]O_{10}(OH)_8$), while the Bourdelle thermometer (Bourdelle et al., 2013) uses as end-members Al-free Fe-chlorite ($Fe_6Si_4O_{10}(OH)_8$), Al-free Mg-chlorite ($Mg_6Si_4O_{10}(OH)_8$), Mg-amesite ($Al_2Mg_4[Al_2Si_2]O_{10}(OH)_8$), Fe-amesite ($Al_2Fe_4[Al_2Si_2]O_{10}(OH)_8$), Fe-sudoite ($Al_3Fe_2\square_1[AlSi_3]O_{10}(OH)_8$) and Mg-sudoite ($Al_3Mg_2\square_1[AlSi_3]O_{10}(OH)_8$). To estimate chlorite temperature by using the Bourdelle thermometer, quartz and water activities are considered equal to 1 and all iron is considered as Fe^{2+}. Besides, the approach of Vidal et al. (2005 and 2006) proposes a coeval estimate of Fe^{3+} content in chlorite and equilibrium temperature at a given pressure. This approach is based on multiequilibrium, i.e. it calculates simultaneously four chlorite-quartz equilibria. The position of these equilibria depends on chlorite end-member, quartz and water activities. In this work, temperatures and Fe^{3+} content were estimated for each chlorite analysis by considering water activity equal to 1, and 5 kbar as the maximum reasonable pressure. According to Vidal et al. (2005 and 2006), thermodynamic equilibrium is obtained when, considering the minimum Fe^{3+} proportion, the temperature difference between the four used equilibria is less than 30 °C (Lanari et al., 2012 and references therein). Grosch et al. (2012) have shown that maximum temperatures are derived for minimum Fe^{3+} contents, but equilibrium between the four chlorite equilibria can be maintained at lower temperature for increasing Fe^{3+} contents. Several crystallochemical and thermodynamic criteria, specific to each model, allow discarding inadequate compositional analysis, such as those including smectitic compositions.

Bourdelle, F., Parra, T., Chopin, C., Beyssac, O.: A new chlorite geothermometer for diagenetic to low-grade metamorphic conditions, Contributions to Mineralogy and Petrology, 165(4), 723-735, 2013.

Grosch, E.G., Vidal, O., Abu-Alam, T., McLoughlin, N.: P–T constraints on the metamorphic evolution of the Paleoarchean Kromberg type-section, Barberton greenstone belt, South Africa, Journal of Petrology, 53(3), 513-545, 2012.

Vidal, O., Parra, T., Vieillard, P.: Thermodynamic properties of the Tschermak solid solution in Fe-chlorite: application to natural examples and possible role of oxidation, American Mineralogist, 90, 347-358, 2005.

Vidal, O., de Andrade, V., Lewin, E., Muñoz, M., Parra, T., Pascarelli, S.: P-T-deformation-Fe3+/Fe2+ mapping at the thin section scale and comparison with XANES mapping. Application to a garnet-bearing metapelite from the Sambagawa metamorphic belt (Japan), Journal of Metamorphic Geology, 24, 669-683, 2006.

Raman Spectroscopy of carbonaceous material calculations

Spectra were processed with the software Peakfit. For higher temperature rocks (330-650 °C), Beyssac et al. (2002) established a correlation between temperature and CM Raman ratio parameter R2 (defined as $R2=D1/(G+D1+D2)$, where G is the area of a single main spectral band $\approx$ 1580 cm-1 that corresponds to the Raman spectrum of perfect graphite, and D1 and D2 are the areas of minor bands at $\approx$ 1350 cm-1 and $\approx$ 1620 cm-1, respectively, which correspond to disorganized CM). The R2 parameter is temperature dependent through the equation $T(°C)=-45R2+641$. R2 ranges from 0 to 0.7 and is inversely proportional to the temperature, which varies from 330 to 650 °C $\pm$ 10-15 °C (Beyssac et al., 2004). For lower temperature rocks (<330 °C), the spectrum is more complex and composed of the graphite G band that overlaps with the D2 band ($\approx$ 1620 cm-1), D1 band ($\approx$ 1350 cm-1), plus D3 ($\approx$ 1500 cm-1) and D4 ($\approx$ 1200 cm-1) bands. There are two area ratios (RA) that relate the evolution of the Raman spectrum with increasing metamorphic grade: $RA1=(D1+D4)/(D1+D2+D3+D4+G)$ and $RA2=(D1+D4)/(D2+D3+G)$. The relationship between the area ratios and the temperature is $RA1=0.0008T+0.3758$ and $RA2=0.0045T+0.27$.

Beyssac, O., Goffé, B., Chopin, C., Rouzaud, J.N.: Raman spectra of carbonaceous material in metasediments: a newgeothermometer, Journal of Metamorphic Geology, 20, 859-871, doi: 10.1046/j.1525-1314.2002.00408.x, 2002.

Beyssac, O., Bollinger, L., Avouac, J.P., Goffé, B.:Thermal metamorphism in the lesser Himalaya of Nepal determined from Raman spectroscopy of carbonaceous material, Earth and Planetary Science Letters, 225, 233-241, doi: 10.1016/j.epsl.2004.05.023, 2004.

RSCM data

R2 values and calculated maximum temperatures from all the Raman Spectra (RS) of CM analyzed in samples from the lower formations. Std Dv: standard deviation. Std Err: standard error (calculated as the standard deviation divided by $\sqrt{n}$).

RS (n=19)	R2	T_{max} (°C)	RS (n=15)	R2	T_{max} (°C)	RS (n=18)	R2	T_{max} (°C)	RS (n=15)	R2	T_{max} (°C)
Mean	0.489	424	Mean	0.246	532	Mean	0.360	481	Mean	0.382	471
Std Dv	0.064	28	Std Dv	0.063	28	Std Dv	0.053	24	Std Dv	0.054	24
Std Err		7	Std Err		7	Std Err		6	Std Err		6
PLB-79-10	0.520	409	PLB-82-1	0.255	527	PLB-84-1	0.371	476	PLB-87-1	0.268	522
PLB-79-11	0.507	415	PLB-82-10	0.255	528	PLB-84-12	0.405	461	PLB-87-10	0.363	480
PLB-79-12	0.495	421	PLB-82-11	0.229	539	PLB-84-13	0.351	485	PLB-87-13	0.455	438
PLB-79-13	0.522	409	PLB-82-12	0.220	543	PLB-84-14	0.392	466	PLB-87-15	0.423	453
PLB-79-14	0.501	418	PLB-82-16	0.142	578	PLB-84-15	0.413	457	PLB-87-16	0.370	476
PLB-79-15	0.528	406	PLB-82-19	0.203	550	PLB-84-16	0.303	506	PLB-87-18	0.388	468
PLB-79-16	0.513	413	PLB-82-2	0.228	539	PLB-84-17	0.446	443	PLB-87-19	0.445	443
PLB-79-17	0.490	423	PLB-82-20	0.189	557	PLB-84-18	0.328	495	PLB-87-2	0.304	506
PLB-79-19	0.548	397	PLB-82-21	0.157	571	PLB-84-19	0.418	455	PLB-87-20	0.465	434
PLB-79-2	0.351	485	PLB-82-22	0.273	520	PLB-84-2	0.264	524	PLB-87-21	0.381	472
PLB-79-20	0.513	413	PLB-82-23	0.314	501	PLB-84-20	0.319	499	PLB-87-22	0.362	480
PLB-79-21	0.584	381	PLB-82-24	0.359	481	PLB-84-21	0.299	508	PLB-87-24	0.363	479
PLB-79-22	0.496	420	PLB-82-25	0.338	491	PLB-84-3	0.347	487	PLB-87-7	0.393	466
PLB-79-3	0.504	417	PLB-82-7	0.298	509	PLB-84-5	0.306	505	PLB-87-8	0.345	487
PLB-79-4	0.404	461	PLB-82-8	0.229	539	PLB-84-6	0.444	443	PLB-87-9	0.403	462
PLB-79-5	0.371	476				PLB-84-7	0.389	468			
PLB-79-6	0.414	457				PLB-84-8	0.331	494			
PLB-79-8	0.446	442				PLB-84-9	0.353	484			
PLB-79-9	0.576	385									

RS (n=21)	R2	T_{max} (°C)	RS (n=19)	R2	T_{max} (°C)	RS (n=19)	R2	T_{max} (°C)	RS (n=20)	R2	T_{max} (°C)
Mean	0.396	465	Mean	0.502	418	Mean	0.329	495	Mean	0.411	458
Std Dv	0.044	20	Std Dv	0.027	12	Std Dv	0.052	23	Std Dv	0.039	17
Std Err		4	Std Err		3	Std Err		5	Std Err		4
PLB-88-1	0.339	490	PLB-89-31	0.542	400	PLB-93-1	0.225	541	PLB-7C-10	0.453	439
PLB-88-10	0.387	469	PLB-89-32	0.459	437	PLB-93-10	0.306	505	PLB-7C-11	0.373	475
PLB-88-11	0.451	440	PLB-89-33	0.506	416	PLB-93-11	0.319	499	PLB-7C-12	0.460	436
PLB-88-12	0.398	464	PLB-89-34	0.456	438	PLB-93-12	0.329	494	PLB-7C-13	0.409	459
PLB-88-13	0.346	487	PLB-89-35	0.476	429	PLB-93-13	0.403	462	PLB-7C-14	0.442	444
PLB-88-14	0.402	462	PLB-89-36	0.498	419	PLB-93-14	0.224	541	PLB-7C-15	0.346	487
PLB-88-15	0.377	473	PLB-89-37	0.531	405	PLB-93-15	0.323	497	PLB-7C-16	0.491	422
PLB-88-16	0.391	467	PLB-89-38	0.498	419	PLB-93-16	0.367	478	PLB-7C-17	0.415	456
PLB-88-17	0.399	463	PLB-89-39	0.505	416	PLB-93-17	0.343	488	PLB-7C-18	0.405	461
PLB-88-18	0.411	458	PLB-89-40	0.513	413	PLB-93-18	0.363	480	PLB-7C-19	0.354	483
PLB-88-19	0.405	461	PLB-89-41	0.491	423	PLB-93-19	0.368	477	PLB-7C-2	0.414	457
PLB-88-2	0.363	480	PLB-89-42	0.504	417	PLB-93-20	0.361	480	PLB-7C-20	0.431	449
PLB-88-20	0.500	419	PLB-89-43	0.508	415	PLB-93-3	0.322	498	PLB-7C-21	0.389	468
PLB-88-21	0.391	467	PLB-89-44	0.504	417	PLB-93-4	0.285	514	PLB-7C-22	0.405	461
PLB-88-3	0.354	484	PLB-89-45	0.473	430	PLB-93-5	0.270	521	PLB-7C-3	0.391	467
PLB-88-4	0.353	484	PLB-89-46	0.555	394	PLB-93-6	0.419	455	PLB-7C-4	0.479	428
PLB-88-5	0.478	428	PLB-89-47	0.539	401	PLB-93-7	0.368	477	PLB-7C-6	0.410	459
PLB-88-6	0.363	479	PLB-89-48	0.488	424	PLB-93-8	0.341	489	PLB-7C-7	0.392	467
PLB-88-7	0.387	469	PLB-89-49	0.492	422	PLB-93-9	0.318	500	PLB-7C-8	0.376	473
PLB-88-8	0.360	481							PLB-7C-9	0.385	470
PLB-88-9	0.461	436									

RA1 and RA2 values and calculated maximum temperatures from all the Raman Spectra (RS) of CM analyzed in samples from the Santa Iría formation. Std Dv: standard deviation. Std Err: standard error (calculated as the standard deviation divided by √n).

RS (n=17)	RA1	T_{max} (°C)	RA2	T_{max} (°C)	RS (n=16)	RA1	T_{max} (°C)	RA2	T_{max} (°C)
Mean	**0.629**	**316**	**1.696**	**317**	**Mean**	**0.638**	**327**	**1.761**	**331**
Std Dv	**0.009**	**12**	**0.067**	**15**	**Std Dv**	**0.007**	**9**	**0.053**	**12**
Std Err		**3**		**4**	**Std Err**		**1**		**3**
PLB71-39	0.634	323	1.731	325	**PLB73-1**	0.631	319	1.712	321
PLB71-41	0.605	286	1.531	280	**PLB73-14**	0.630	318	1.701	318
PLB71-42	0.634	323	1.733	325	**PLB73-17**	0.628	316	1.691	316
PLB71-43	0.636	326	1.750	329	**PLB73-20**	0.633	321	1.724	323
PLB71-44	0.633	322	1.726	324	**PLB73-21**	0.636	325	1.748	328
PLB71-45	0.630	317	1.699	318	**PLB73-22**	0.629	317	1.696	317
PLB71-46	0.640	330	1.779	335	**PLB73-23**	0.641	332	1.786	337
PLB71-47	0.628	315	1.689	315	**PLB73-24**	0.637	327	1.756	330
PLB71-48	0.638	327	1.759	331	**PLB73-25**	0.633	322	1.725	323
PLB71-49	0.614	298	1.592	294	**PLB73-26**	0.633	321	1.724	323
PLB71-50	0.636	325	1.747	328	**PLB73-27**	0.643	335	1.805	341
PLB71-52	0.623	309	1.654	308	**PLB73-28**	0.648	341	1.844	350
PLB71-53	0.633	322	1.728	324	**PLB73-29**	0.645	337	1.820	344
PLB71-54	0.637	326	1.753	330	**PLB73-30**	0.643	334	1.800	340
PLB71-55	0.622	308	1.648	306	**PLB73-31**	0.644	335	1.806	341
PLB71-56	0.626	313	1.674	312	**PLB73-6**	0.648	340	1.837	348
PLB71-57	0.620	305	1.630	302					