Data Repository Item 2002053 – Sampling technique and statistical analysis descriptions

Sampling technique description

Data collection involved four steps: **1)** *Sample collection*: From each outcrop, samples (~3-5 kg each) were collected at set intervals along a measuring tape oriented at a high angle to lithologic layering or foliation (see Figure DR1). Veins are commonly surrounded by a zone of altered rock, so larger samples (up to 16 kg) were taken from highly veined outcrops to include vein, altered selvage, and host rock. The average outcrop traverse was ~50 m long and consisted of 26 samples. The Macraes Flat Au-W deposit (see Table DR1) had to be sampled differently; here, 16 specimens were randomly selected from the mine dumps. **2)** *Sample preparation*: Fresh samples were cut into rectangular slabs of representative elemental volume (oriented orthogonal to any fabric–see Figure DR1), abraded with SiC paper, ultrasonically cleaned in distilled, deionized water, and pulverized in agate mills. (**3)** *Compositing*: Two grams of each pulverized sample from an outcrop were combined and thoroughly mixed in a modified ball mill to create an outcrop composite. Grain densities are relatively constant (range = 2.72–2.82 g/cm^3 – see Table DR1) for both low- and high-grade TZ metasediments; thus mass composites are equivalent to volume composites (grain density = rock density on a porosity free basis). **4)** *Analysis*: The chemical composition of each composite was analyzed using X-Ray Fluorescence and ICP-MS (see Table DR1). All samples from one representative outcrop traverse were analyzed and averaged to evaluate the effectiveness of our compositing technique (see Figure DR2). The individual sample averages are not significantly different from our composite analysis for the outcrop.

Univariant statistical analysis

Univariant comparisons of compositional ratios first involved an F-test to determine if the distributions had significantly different variances. If not, then the standard Student's t-test was used, otherwise, a t-test for distributions with unequal variances was used. Computer subroutines used for these tests and for the Two-Dimensional Kolmogorov-Smirnov (K-S) tests are from Press, W.H., Teukolsky, S.A., Vetterling, W.T., and Flannery, B.P., 1992, Numerical recipes in Fortran 77: The art of scientific computing, 2nd edition: New York, Cambridge, 963 p. Logratio averaging methods (Ague, J.J., and van Haren, J.L.M., 1996, Assessing metasomatic mass and volume changes using the bootstrap, with application to deep crustal hydrothermal alteration of marble: Economic Geology, v. 91, p. 1169-1182.) were calculated for all statistical analysis and yielded nearly identical results.

Data Repository Item -- Table DR1

Table DR1. XRF analyses were performed by X-Ray Assay Laboratories (XRAL) in Don Mills, Ontario. Major elements (A) were determined on glass beads and trace elements (B) on pressed pellets (Rb, Sr, Zr, Ba) and by ICPMS (W*). Total Fe is reported as Fe_2O_3. Detection limits were 0.01 wt% for major elements (0.001 for TiO_2) and 2 ppm for pressed pellet trace elements (20 for Ba). ICPMS analysis detection limits were 0.05 ppm (W*). W* concentrations are aqua regia leach fractions. These fractions are considered proxies for the most easily mobilized W (from Fe- and Fe-Ti oxides, common sulfides, and grain boundaries) and represent the W that is most likely involved in ore metal transport and deposition by common metamorphic fluids.

A

Composite outcrop sample	Locality	NZ grid reference	Traverse length (m)	Number of samples	SiO_2 (wt%)	Al_2O_3 (wt%)	CaO (wt%)	MgO (wt%)	Na_2O (wt%)	K_2O (wt%)	Fe_2O_3 (wt%)	MnO (wt%)	TiO_2 (wt%)	P_2O_5 (wt%)	LOI (wt%)	Sum
JANZ- 5	N. of Omarama	H39 699340	80	41	63.3	16.2	2.78	2.16	3.25	2.05	5.71	0.09	0.725	0.17	3.40	99.9
JANZ- 8	Lindis Pass Rd	G40 335023	50	26	66.0	15.3	2.42	1.60	3.39	2.70	4.20	0.06	0.622	0.16	2.15	98.7
JANZ- 9	Lindis Pass Rd	G40 315068	6	13	67.0	15.4	2.30	1.44	3.78	2.87	4.12	0.07	0.565	0.13	2.10	100.0
JANZ-10	Lindis Pass Rd	G40 316067	50	26	66.9	15.0	2.13	1.58	3.85	2.67	4.15	0.07	0.588	0.11	1.90	99.2
JANZ-12	W. of Queenstown	E41 650637	46	25	63.8	15.1	3.93	2.07	3.57	1.78	5.53	0.09	0.664	0.17	2.35	99.2
JANZ-13	Falls Dam	H41 653881	50	26	64.3	16.1	2.40	1.97	3.44	2.90	4.75	0.07	0.643	0.17	2.20	99.2
JANZ-14	Fruitlands-Roxburgh Rd	G43 190301	7.5	18	60.1	16.2	5.06	2.69	3.67	1.83	6.46	0.10	0.807	0.18	1.90	99.2
JANZ-15	Beaumont	G44 400820	33	33	70.5	13.4	2.13	1.11	4.31	2.21	3.15	0.06	0.475	0.09	1.65	99.2
JANZ-18	S. of Middlemarch	H43 840096	14	28	68.1	14.4	1.96	1.31	3.77	2.23	3.68	0.06	0.514	0.12	2.25	98.6
JANZ-20	Beaumont-Rongahere Rd	G44 373719	18	19	66.3	15.8	1.62	1.42	3.52	3.39	4.07	0.06	0.628	0.15	2.20	99.4
JANZ-24	Menzies Rd	I39 280295	50	27	65.3	15.7	2.75	1.89	3.44	2.55	4.62	0.08	0.640	0.17	2.70	100.0
JANZ-25	Myers Pass Rd	J39 323104	39	41	66.0	15.8	2.33	1.50	3.83	3.05	3.82	0.07	0.597	0.16	1.90	99.3
JANZ-26	Dansey Pass Rd	I41 182821	18	38	65.0	15.6	2.45	1.99	3.29	2.47	4.87	0.07	0.633	0.15	2.90	99.6
JANZ-27	Macraes Flat	I42 105336	N/A[1]	16	64.1	15.3	1.97	2.30	3.28	2.32	5.81	0.08	0.753	0.18	3.20	99.4
JANZ-28	Benmore Dam Rd	H39 867235	60	31	62.4	16.6	2.41	1.93	2.97	2.72	6.11	0.08	0.758	0.16	3.00	99.2
JANZ-32	Cromwell Gorge	G41 118657	100	52	68.2	14.2	2.58	1.51	3.62	2.48	3.74	0.05	0.517	0.13	2.20	99.4
JANZ-33	Hawea neck	F39 073337	50	26	67.2	15.2	2.49	1.53	3.57	2.33	4.34	0.07	0.574	0.12	2.25	99.8
JANZ-35	W. of Wanaka	F40 913095	50	26	63.9	15.3	2.13	1.75	3.12	2.16	5.35	0.11	0.670	0.15	4.60	99.4
JANZ-36	East side Lake Wanaka	F39 063395	50	26	65.2	14.7	3.58	2.33	3.88	1.76	5.59	0.10	0.691	0.17	1.70	99.8
JANZ-70	W. of Lake Ohau	H38 528595	47	48	65.6	15.8	2.50	1.74	3.32	2.86	4.38	0.07	0.596	0.17	2.65	99.8
JANZ-71	Twizel-Omarama Rd	H38 759517	50	26	64.4	15.5	2.99	2.22	3.16	2.40	5.09	0.07	0.713	0.19	2.35	99.2
Average prism[2]	---	---	---	---	65.4	15.3	2.62	1.81	3.53	2.45	4.75	0.08	0.64	0.15	2.46	99.2

B

Composite outcrop sample	Locality	Terrane	Textural zone[3]	Grain density (g/cm^3)	Rb (ppm)	Sr (ppm)	Zr (ppm)	Ba (ppm)	W*[6] (ppm)
JANZ- 5	N. of Omarama	Torlesse	I	2.79	88	240	164	442	0.58
JANZ- 8	Lindis Pass Rd	Torlesse	IIA	2.82	109	308	222	585	N/A[5]
JANZ- 9	Lindis Pass Rd	Torlesse	IIA	N/A[5]	105	317	212	667	N/A[5]
JANZ-10	Lindis Pass Rd	Torlesse	IIB	2.80	98	287	203	688	0.15
JANZ-12	W. of Queenstown	Caples	III	2.80	63	344	145	477	0.16
JANZ-13	Falls Dam	Torlesse	I	2.74	109	386	177	629	0.49
JANZ-14	Fruitlands-Roxburgh Rd	Caples	III	2.77	56	453	150	517	0.11
JANZ-15	Beaumont	Caples	III	2.74	84	130	197	470	0.37
JANZ-18	S. of Middlemarch	Torlesse	IV	2.74	91	261	201	502	0.10
JANZ-20	Beaumont-Rongahere Rd	Caples	IIA	2.75	126	191	205	608	0.28
JANZ-24	Menzies Rd	Torlesse	IIA	2.76	103	238	188	594	0.43
JANZ-25	Myers Pass Rd	Torlesse	IIA	2.74	98	338	198	662	0.64
JANZ-26	Dansey Pass Rd	Torlesse	III[4]	2.81	101	232	166	539	0.19
JANZ-27	Macraes Flat	Torlesse	III-IV	2.78	81	200	160	558	0.43
JANZ-28	Benmore Dam Rd	Torlesse	I	2.73	99	285	155	476	0.64
JANZ-32	Cromwell Gorge	Torlesse	IV	2.74	90	406	188	627	0.16
JANZ-33	Hawea neck	Torlesse	III	2.74	91	300	169	662	0.14
JANZ-35	W. of Wanaka	Torlesse	IV	2.77	97	179	184	551	0.07
JANZ-36	East side Lake Wanaka	Torlesse	IV	2.72	58	352	164	484	0.14
JANZ-70	W. of Lake Ohau	Torlesse	I	2.78	108	496	185	708	0.59
JANZ-71	Twizel-Omarama Rd	Torlesse	I	2.81	92	365	178	523	0.47
Average prism[2]	---	---	---	---	92	300	181	569	---

[1] The samples collected at Macraes Flat were randomly selected from dump piles of unmineralized material in the mine pits.

[2] Logratio averaging methods (Ague, J.J., and van Haren, J.L.M., 1996, Assessing metasomatic mass and volume changes using the bootstrap, with application to deep crustal hydrothermal alteration of marble: Economic Geology, v. 91, p. 1169-1182.) yield nearly identical results.

[3] Textural zone designations from Mortimer, N., 1993, Geology of the Otago Schist and adjacent rocks. Scale 1:500,000. Institute of Geological and Nuclear Sciences Geological Map 7. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Ltd. and Turnbull, I.M., Mortimer, N., and Craw, D., 2001, Textural zones in the Haast Schist--a reappraisal: New Zealand Journal of Geology and Geophysics, v. 44, p. 171-183.

[4] Sample JANZ-26 has been re-classified as TZ III based on the mica grain size criteria of Turnbull et al. (2001).

[5] Grain density and W data were not available for these samples.

[6] Reported W* concentrations are 80-90^{o}C aqua regia leach fractions.

Data Repository Item -- Figure DR1

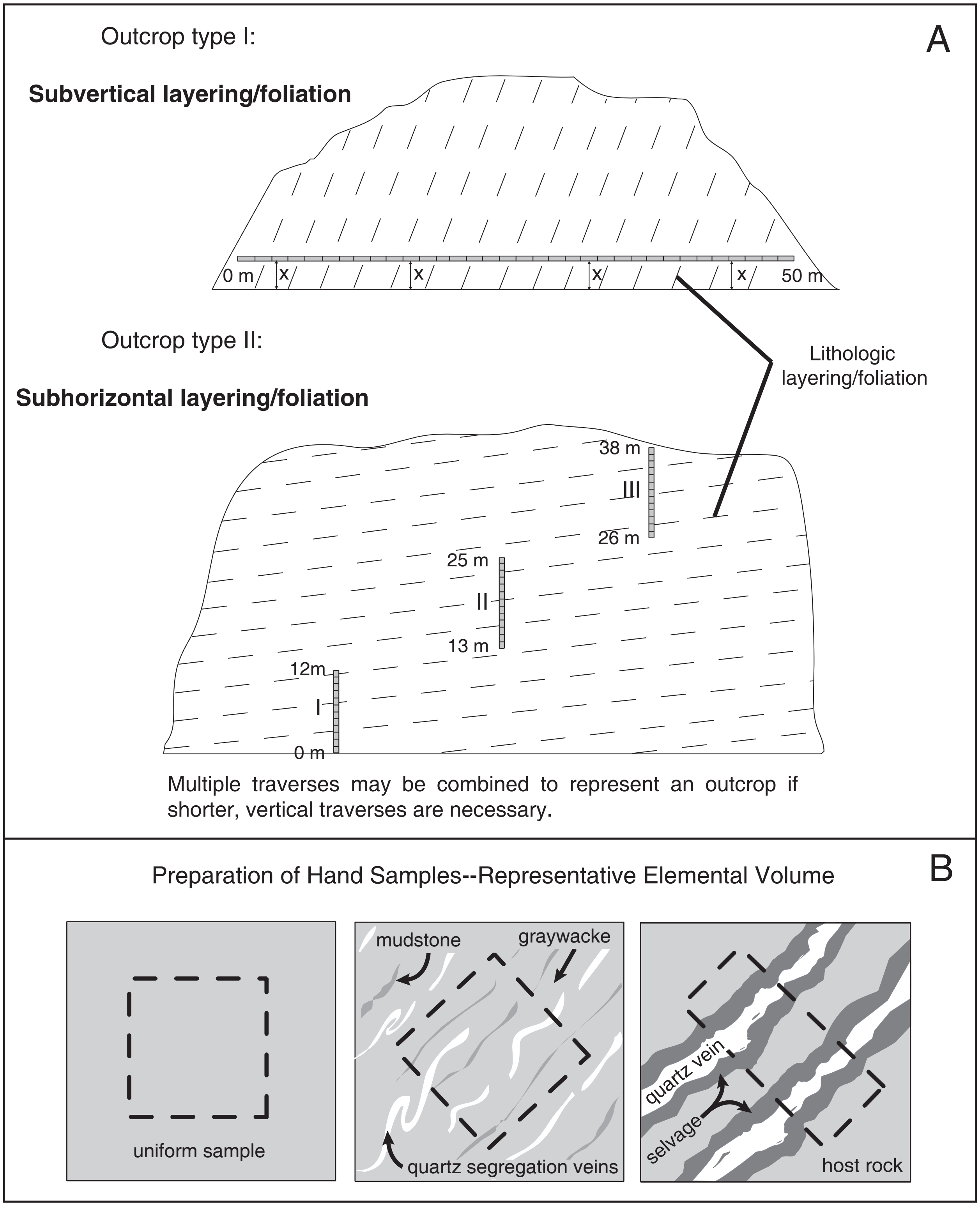

Figure DR1. Diagrams of traverse sampling technique and sample preparation procedure. A: Measuring tapes were oriented along outcrops at high angles to lithologic layering/foliation. Samples were collected at set intervals along the tapes. For outcrops with near vertical foliation or layering, multiple vertical traverses were combined to represent the outcrop, with special care taken to avoid resampling of the same layers. Average outcrop length was ~50 m and consisted of 26 samples. Outcrop vein and metapelite abundances were calculated from vein and lithology measurements along the same tapes. B: Diagrams of hand samples from outcrop traverses. Dashed boxes indicate cut slabs of representative elemental volume. Representative elemental volume, as applied in our study, is the minimum sample volume that retains the average chemical composition of the whole sample.

Data Repository Item -- Figure DR2

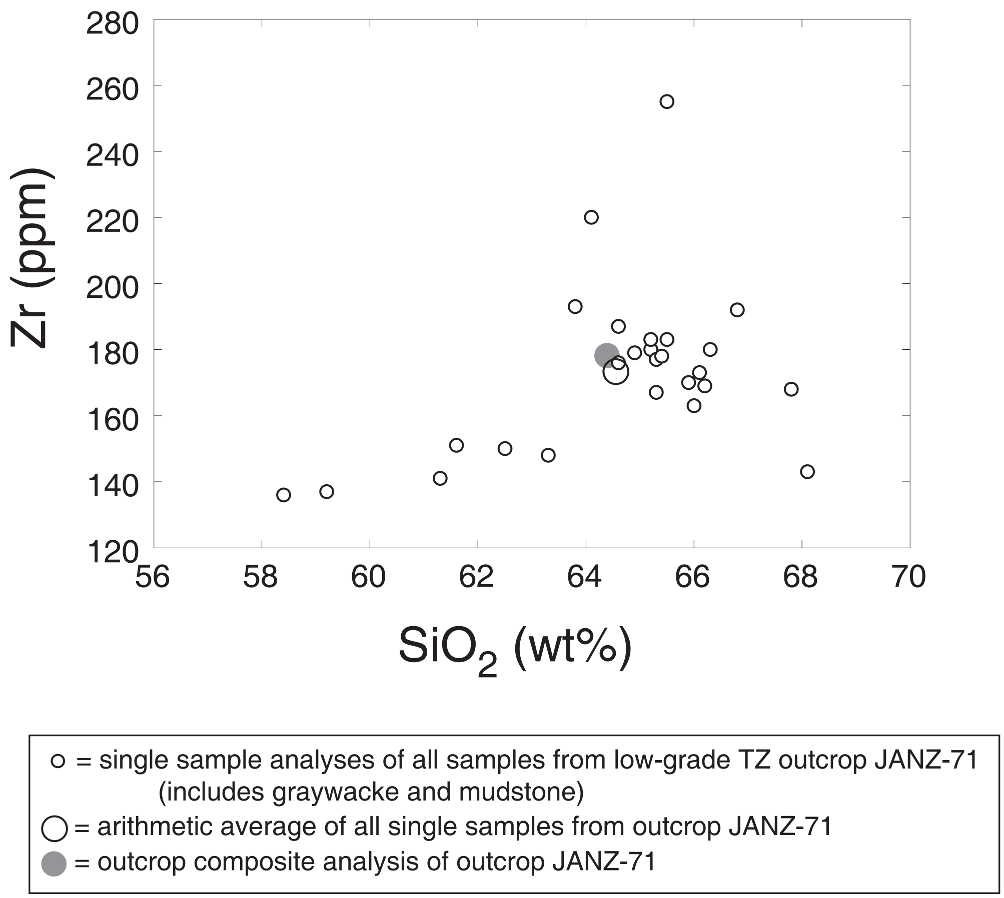

Figure DR2. SiO_2 vs Zr plot for all single samples from low-grade TZ outcrop JANZ-71. Arithmetic average of single sample compositions is nearly identical to the composited analysis, confirming that the new traverse-based, outcrop sampling technique is effective in averaging out the hand sample variability that has plagued many previous mass balance investigations.