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Data

Geochemical analyses of sandstones and mudstones from the Siwalik succession, Surai Khola, western Nepal

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Abstract

This report contains whole-rock major and trace element XRF analyses of Middle Miocene to Pleistocene Siwalik Group sandstones (96) and mudstones (80) from the Surai Khola section of western Nepal. All were analyzed by X-ray fluorescence for the major elements and 14 trace elements. The data form part of a larger study of the geochemistry of the Siwalik Group, and supplement a similar data set from the Siwaliks in the Bakiya Khola section in central Nepal (Ulak et al., this volume). Analyses are reported for the Bankas (n=21), Chor Khola (n=62), Surai Khola (n=41), Dobata (n = 32) and Dhan Khola Formations (n=20), in ascending stratigraphic order. Normalization of average sandstone and mudstone from each formation against average upper continental crust (UCC) shows Na and Sr are strongly depleted relative to UCC, whereas several immobile elements (e.g. Zr, Th, Sc, Ti) are slightly enriched. However, fractionation between sandstone and mudstone within each formation is limited, particularly in the upper part of the section, and in comparison to the Bakiya Khola section in central Nepal. This suggests that some lateral geochemical variation exists within the Siwalik succession. This aspect will be the subject of future work.

Key words: Sedimentary rocks, geochemistry, major and trace elements, Siwalik Group, Surai Khola, Nepal

Introduction

The Siwalik succession of southwestern Nepal consists of a thick pile of sediments spanning an age range between Middle Miocene to Pleistocene. The Siwalik sediments are mainly fluvial in origin, and were mostly derived from the northern and northeastern Himalayan suites. The Siwalik Group has been investigated by many workers, including studies of biostratigraphy, magnetostratigraphy, isotopic dating, sedimentology, petrography and tectonics (Appel et al., 1991; Critelli and Ingersoll, 1994; Dhital et al., 1995; Gautam and Rösler, 1999; Nakayama and Ulak, 1999; Roser et al., 2002; Robinson et al., 2006; Szulc et al., 2006; Najman, 2006; and many others).

Geochemical studies of sedimentary rocks are useful for the evaluation of source weathering, climate, provenance and sedimentary processes (Nesbitt and Young, 1982; McLennan et al., 1993; Johnsson, 1993; Roser and Korsch, 1988; and others). This report presents whole-rock major and trace element analyses of 176 Siwalik Group sandstones and mudstones from the Surai Khola section of western Nepal, as a companion to a similar dataset from the Bakiya Khola section in central Nepal (Roser et al., 2002; Ulak et al., this volume). These datasets provide a framework for on-going study of vertical and spatial changes in geochemistry within the Siwalik succession.

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General Geology

Sedimentary rocks of the Siwalik Group are extensively distributed in the southern frontal area of the Himalaya (Nakayama and Ulak, 1999). The Siwalik Group is bounded by the Main Boundary Thrust (MBT) to the north and the Main Frontal Thrust (MFT) in the south (Fig. 1). The Siwalik Group consists of fluvial sediments derived from the Greater Himalayan, Lesser Himalayan and Tibetan Himalayan suites (Szulc et al., 2006; Nakayama and Ulak, 1999), in a succession some 6000 m thick. The sediments are dominated by mudstones, siltstones, sandstones and conglomerates, and are informally divided into lower, middle and upper units.

In the Surai Khola area, the Siwalik Group is subdivided into the Bankas, Chor Khola, Surai Khola, Dobata and Dhan Khola Formations, in ascending order (Table 1). The Bankas Formation (580+ m) consists of alternations of medium- to very fine-grained gray sandstones and variegated mudstones, deposited by a fine-grained meandering fluvial system (Nakayama and Ulak, 1999). The Bankas sandstones also contain palaeosols and wood fragments. The overlying Chor Khola Formation (1230 m) is made up of coarse- to fine-grained sandstones and mudstones in almost equal proportions, and is subdivided into the lower Jungli Khola and upper Shivgarhi members. The Jungli Khola member was deposited from a fine-grained meandering fluvial system similar to that of the Bankas Formation, whereas the Shivgarhi member was the product of a flood-flow dominated fine-grained meandering system (Nakayama and Ulak, 1999). The succeeding Surai Khola Formation (1310 m) mainly consists of coarse- to medium-grained "pepper and

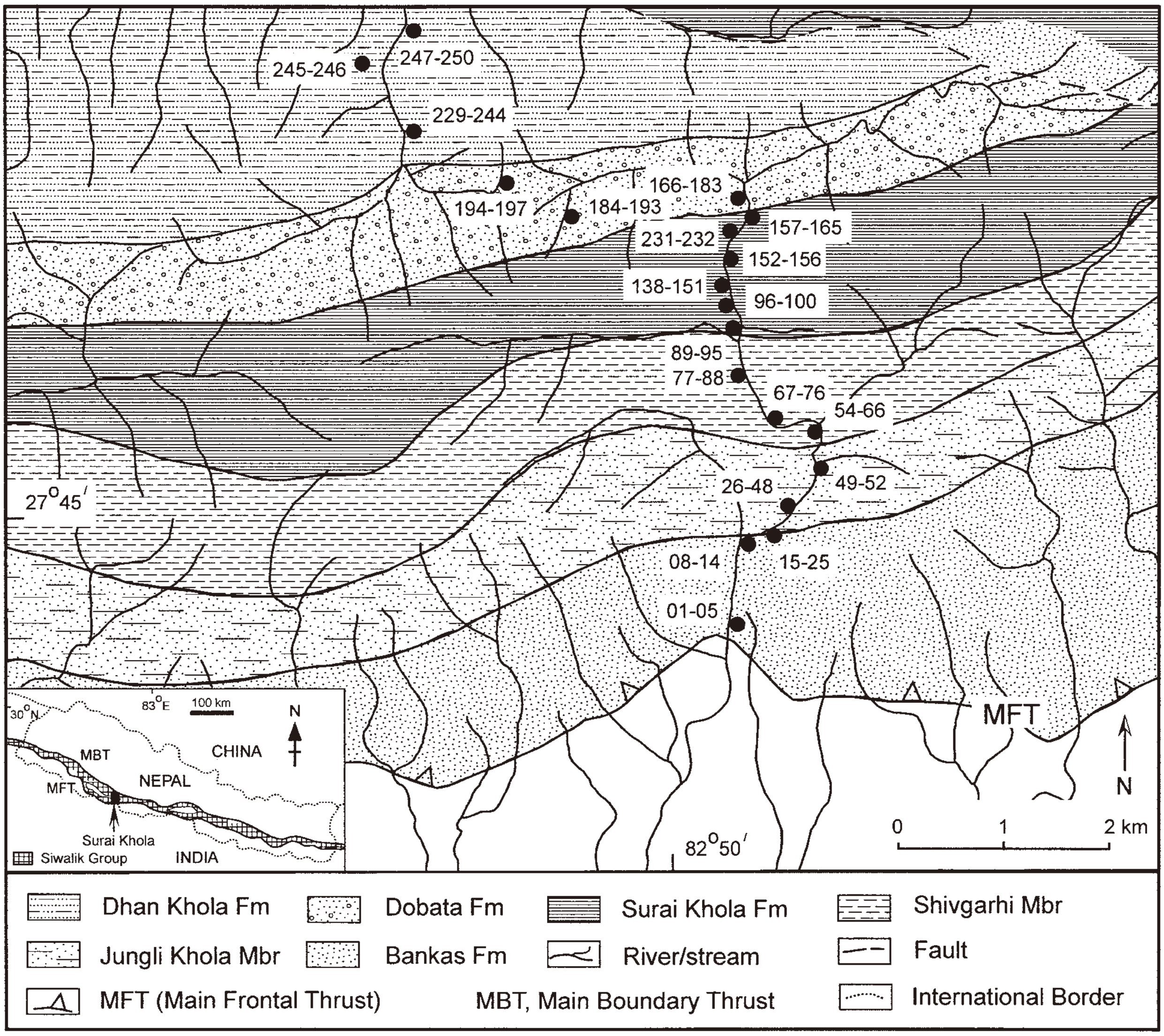

Fig. 1. Geological map of the Surai Khola area (Dhital et al., 1995) showing sample locations (grouped by sample number), lithotypes and major geographic features.

salt" sandstones, and is subdivided into lower, middle, and upper members on the basis of lithology. Facies associations indicate that these represent successive deposition from flood-flow dominated sandy meandering, shallow sandy braided, and deep sandy braided fluvial systems, respectively (Nakayama and Ulak, 1999). The Dobata Formation (750 m) is mainly composed of massive mudstones, along with medium- to coarse-grained sandstones, and occasionally contains cobbles. It was the product of an anastomosing fluvial system (Nakayama and Ulak, 1999). The Dhan Khola Formation (1100+ m), the uppermost in the succession, consists of conglomerates containing pebbles and cobbles of quartzite and limestone originating from the Lesser Himalaya, along with unconsolidated sandstones. The lower part of the Dhan Khola Formation was the product of a gravelly braided river system, whereas the upper part was deposited in a debris-flow dominated braided environment (Nakayama and Ulak, 1999).

Analytical Methods

A total of 176 sandstone and mudstone samples were analyzed from the Surai Khola section. Sample handling and crushing methods were the same as those described for the companion suite from the Bakiya Khola section (Ulak et al., this volume). Loss on Ignition (LOI) was determined from the net weight loss after ignition in a muffle furnace at 1020℃ for at least 2 hours. The major elements and 14 trace elements (Ba, Ce, Cr, Ga, Nb, Ni, Pb, Rb, Sc, Sr, Th, V, Y, Zr) were determined on the ignited samples after the determination of LOI (anhydrous basis), using a Rigaku RIX 2000 X-ray fluorescence spectrometer (XRF) at Shimane University. Glass fusion beads were made using an alkali flux (80% lithium tetraborate, 20% lithium metaborate), with a flux to sample ratio of 2:1 (Kimura and Yamada, 1996). Instrument conditions and calibration also followed those described by Kimura and Yamada (1996). Additional details of the XRF sample preparation and analysis methodology used at Shimane University are also given by Roser et al. (1998, 2000, 2003).

Results

Major and trace element analyses of the sandstones and mudstones from the Surai Khola succession are listed in Table 2 (hydrous basis), arranged in stratigraphic order. Total iron content is expressed as Fe_2O_3T. LOI values are generally between 2 to 10 wt%, but some samples have significantly higher values (> 10 wt%) due to high carbonate contents.

Average values for sandstones and mudstones in each formation are listed in Table 3. Some stratigraphic variability is evident, as in the Bakiya Khola section (Roser et al., 2002; Ulak et al., this volume). Average SiO_2 abundances in the sandstones range from 60.90 wt% in the Chor Khola Formation to 70.83 wt% in the Dhan Khola Formation, levels similar to that in upper continental crust. Variability is less than in the Bakiya Khola section (Ulak et al., this volume). Average SiO_2 abundances in the mudstones show an even smaller range of 61.49 wt% (Chor Khola) to 66.33 wt% (Dhan Khola). Average CaO contents in both sandstones and mudstones of the Bankas, Chor Khola and Surai Khola Formations are significantly greater (up to 9.10 wt%) than in the Dobata and Dhan Khola averages (Table 3). This follows a similar pattern to the Bakiya Khola data (Ulak et al., this volume).

Average trace element abundances in the mudstones in each formation are generally higher than in their companion sandstones, although the contrast varies according to the element, and tends to decrease stratigraphically upward (Table 3). This is illustrated by normalization of the formation averages for each lithotype against upper continental crust (UCC). Some separation occurs between the sandstone and mudstone averages in the Bankas Formation and the individual members of the Chor Khola Formation, especially in the elements at the right of the plot (Al to V; Fig. 2). However, in the Surai Khola, Dobata and Dhan Khola Formations the UCC-normalized patterns of the sandstone and mudstone averages are almost identical (Fig. 2). This probably reflects change in fluvial style, with shift from meandering systems in the lower part to braided depositional environments in the upper part. In general, the contrast between the lithotype averages in each formation is smaller than in equivalents in the Bakiya Khola section, suggesting that some lateral variation occurs within the Siwalik succession. This will be the subject of future examination.

The UCC-normalized plots (Fig. 2) also feature strong depletion in the mobile elements Na and Sr, and slight enrichment of immobile elements (e.g. Zr, Th, Sc, Ti) relative to upper continental crust. CaO is enriched relative to UCC in the lower part, and depleted in the upper part, a pattern also observed in the Bakiya Khola section (Ulak et al., this volume). These features underline the point that although the Siwalik sediments were derived from the rapidly rising crustal section of the Himalaya, their compositions have been modified during their short journey from source to the site of deposition.

Table 1. Stratigraphy of the Siwalik Group, Surai Khola, Nepal (Nakayama and Ulak, 1999).

Formation	Member	Thickness (m)
Dhan Khola		1100+
Dobata		750
Surai Khola	Upper	480
	Middle	470
	Lower	360
Chor Khola	Shivgarhi	820
	Jungli Khola	410
Bankas		580+

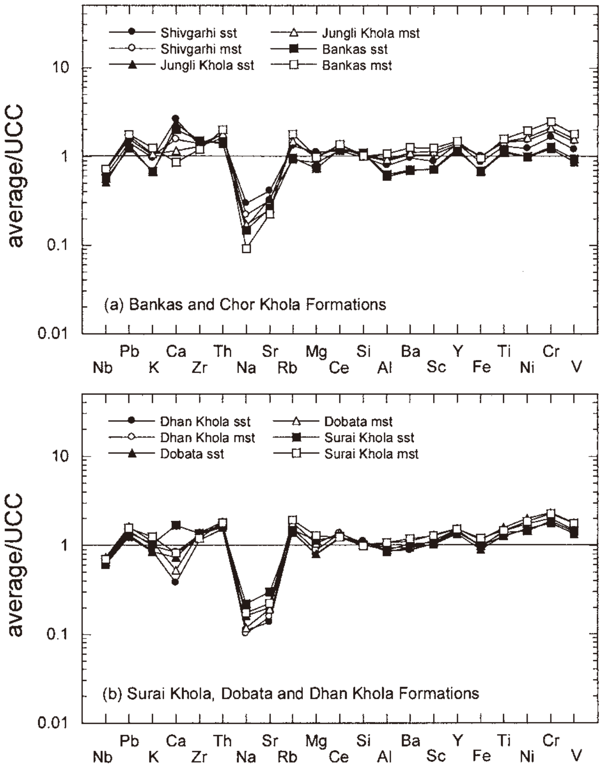

Fig. 2. Multi-element plot sandstone and mudstone averages for each formation normalized against the average upper continental crust (UCC) composition of Taylor and McLennan (1985). Elements are arranged from left to right in order of increasing abundance in average Mesozoic-Cenozoic greywacke (Condie, 1993) relative to UCC, following the methodology of Dinelli et al. (1999). The Shivgarhi and Jungli Khola members of the Chor Khola Formation are plotted individually.

Acknowledgements

This report continues work started by the late Katsuhiro

Table 2. Whole rock major (wt%) and trace element (ppm) analyses of outcrop samples from the Siwalik Group, Surai Khola, Nepal (hydrous basis). SaNr = sample number; Lith = lithology (m, medium; f, fine; sst, sandstone; mst, mudstone); LOI = loss on ignition; n.d. = not detected.

SaNr	Metres	Lith	SiO_2	TiO_2	Al_2O_3	Fe_2O_{3T}	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total	Ba	Ce	Cr	Ga	Nb	Ni	Pb	Rb	Sc	Sr	Th	V	Y	Zr
Dhan Khola Formation																												
SNS-250	4824	f sst	79.03	0.57	9.80	4.10	0.03	1.02	0.50	0.51	2.08	0.07	2.43	100.16	387	77	46	10	14	24	23	118	8.8	31	14.5	63	27	286
SNS-249	4788	mst	67.88	0.75	15.44	5.12	0.03	1.75	0.95	0.55	3.64	0.09	4.33	100.52	592	92	81	19	18	34	34	194	17.4	40	20.1	92	35	253
SNS-248	4775	f sst	58.47	0.80	19.60	6.68	0.13	2.37	1.16	0.35	4.63	0.11	5.96	100.28	651	81	90	27	19	51	41	238	17.1	43	21.6	128	40	155
SNS-247	4738	mst	54.53	0.76	17.95	5.59	0.07	2.26	5.38	0.24	4.35	0.08	8.55	99.77	586	76	87	24	19	43	36	214	15.5	55	21.1	114	33	151
SNS-246	4656	mst	67.60	0.69	13.64	4.16	0.03	1.60	2.84	0.57	3.19	0.10	5.46	99.87	497	85	59	18	16	31	30	166	10.2	54	16.7	89	33	242
SNS-245	4650	mst	67.80	0.70	12.96	3.88	0.04	1.35	3.70	0.29	2.92	0.07	5.77	99.50	474	81	66	15	16	27	26	156	11.8	45	17.9	82	29	266
SNS-244	4631	m sst	75.77	0.58	11.67	4.42	0.02	1.22	0.49	0.49	2.64	0.08	2.98	100.38	430	79	58	13	14	27	23	148	9.4	28	15.6	75	30	230
SNS-243	4629	mst	65.29	0.75	16.21	5.17	0.03	1.73	1.46	0.30	3.74	0.09	5.11	99.89	577	86	73	21	18	37	32	198	14.4	37	18.7	99	36	216
SNS-242	4566	mst	61.82	0.63	12.70	4.52	0.04	1.90	6.41	0.39	2.99	0.10	7.85	99.33	462	73	62	15	15	31	22	153	13.1	51	16.2	77	29	198
SNS-241	4459	f sst	65.77	0.75	16.05	6.56	0.10	1.86	0.60	0.36	3.53	0.08	4.34	100.00	631	81	81	22	17	41	37	187	14.9	41	18.0	108	36	205
SNS-240	4513	mst	65.63	0.69	13.63	4.22	0.03	1.45	4.08	0.31	3.19	0.09	6.04	99.35	509	86	73	16	17	28	25	166	12.0	41	19.4	81	32	279
SNS-239	4537	mst	64.19	0.56	19.18	3.50	0.03	1.05	2.51	0.33	2.57	0.08	4.56	98.54	394	75	50	10	12	20	20	120	5.7	31	14.2	64	24	240
SNS-238	4484	mst	69.74	0.64	10.59	4.35	0.04	1.81	3.75	0.68	2.30	0.13	5.36	99.39	389	84	60	11	15	31	24	119	8.4	69	16.7	68	31	305
SNS-237	4462	mst	77.86	0.56	9.61	3.67	0.05	1.28	1.11	0.59	2.08	0.09	2.69	99.59	367	75	47	9	13	26	18	116	5.3	40	14.8	60	29	278
SNS-236	4409	mst	58.10	0.68	15.85	4.86	0.05	2.50	5.04	0.26	3.88	0.10	8.07	99.40	530	70	70	21	17	36	30	188	13.5	64	17.2	94	30	154
SNS-235	4350	m sst	75.44	0.51	10.89	3.81	0.03	1.55	1.35	0.24	2.41	0.08	3.34	99.65	367	64	48	12	12	22	19	136	9.4	28	13.2	68	27	169
SNS-234	4287	m sst	70.50	0.62	11.46	4.22	0.04	1.73	2.97	0.54	2.58	0.10	4.83	99.59	437	76	61	14	15	27	21	136	10.2	58	14.9	67	28	254
SNS-233	4277	mst	74.50	0.48	9.72	3.49	0.03	1.52	2.70	0.33	2.12	0.08	4.51	99.48	358	67	45	10	12	22	20	119	10.0	45	13.3	58	23	188
SNS-230	4233	mst	73.54	0.76	13.51	4.05	0.03	1.33	0.46	0.22	2.58	0.03	3.85	100.35	406	94	74	17	19	53	31	148	13.6	34	18.2	88	37	289
SNS-229	3974	mst	60.11	0.72	14.93	4.91	0.07	3.47	3.50	0.21	3.64	0.10	7.93	99.60	518	87	71	20	18	39	32	177	12.3	94	18.1	96	33	199
Dobata Formation																												
SNS-197	3794	mst	69.48	0.71	10.74	3.34	0.04	1.65	4.06	0.35	2.53	0.08	6.28	99.25	446	102	54	12	18	27	24	128	7.7	57	17.9	67	32	553
SNS-196	3700	f sst	74.16	0.57	10.04	3.90	0.02	1.04	1.38	0.32	2.03	0.06	6.28	99.80	384	79	46	10	13	24	22	119	10.4	35	15.5	63	26	294
SNS-195	3678	f sst	62.31	0.81	18.31	6.24	0.05	1.97	1.04	0.34	4.23	0.07	5.13	100.50	666	79	87	25	19	42	34	236	16.9	57	20.1	119	30	178
SNS-194	3653	mst	63.76	0.73	15.10	5.08	0.04	1.74	3.35	0.54	3.47	0.08	5.85	99.75	546	83	73	19	17	35	32	178	11.8	51	18.9	88	30	256
SNS-193	3642	mst	71.87	0.71	13.97	4.99	0.08	1.32	0.49	0.53	3.00	0.04	3.44	100.44	506	87	66	17	17	31	31	162	10.4	37	18.0	86	31	224
SNS-192	3584	mst	65.69	0.82	18.22	4.12	0.01	1.63	0.54	0.32	3.71	0.02	5.10	100.18	608	95	86	25	19	40	40	202	14.0	39	21.0	119	41	209
SNS-191	3540	f sst	72.91	0.69	13.82	4.13	0.02	1.53	0.51	0.61	2.99	0.05	3.34	100.60	525	81	68	17	16	29	25	168	10.9	40	17.1	82	29	227
SNS-190	3498	f sst	62.60	0.82	18.03	6.63	0.03	1.96	0.85	0.30	3.96	0.07	4.93	100.18	650	83	97	24	20	46	30	218	15.6	49	21.2	125	34	209
SNS-189	3466	f sst	75.69	0.62	11.34	4.36	0.02	1.15	0.61	0.50	2.16	0.04	3.51	100.00	458	76	64	13	14	34	23	128	11.2	54	14.5	76	28	251
SNS-188	3458	f sst	76.33	0.57	8.16	2.92	0.05	1.45	3.16	0.95	1.67	0.14	3.85	99.25	347	93	35	6	13	15	12	92	7.3	74	19.7	51	31	391
SNS-187	3443	f sst	69.51	0.75	14.20	5.22	0.05	1.86	0.93	0.91	2.94	0.13	3.54	100.03	624	92	83	16	17	41	26	159	12.1	92	19.6	94	31	344
SNS-186	3421	mst	52.66	0.78	17.93	6.79	0.07	2.44	5.40	0.20	4.51	0.09	8.78	99.67	609	78	89	25	19	44	34	217	16.6	74	20.2	114	34	140
SNS-185	3402	f sst	94.34	0.15	2.16	0.55	0.00	0.31	0.10	0.24	0.56	0.01	0.48	98.91	112	37	10	n.d.	4	2	9	40	0.8	11	5.3	3	10	100
SNS-184	3381	mst	62.49	0.84	18.44	5.86	0.03	1.98	0.54	0.35	4.31	0.06	5.05	99.96	692	89	90	25	21	44	37	228	17.5	58	20.4	118	35	189
SNS-183	3320	f sst	61.70	0.84	19.49	5.34	0.02	2.26	0.51	0.22	4.31	0.03	5.41	100.13	668	89	93	28	20	50	46	229	18.5	53	21.2	132	44	169
SNS-182	3310	f sst	71.77	0.71	12.95	4.85	0.03	1.74	0.65	1.10	3.11	0.16	2.59	99.68	611	91	58	15	16	27	23	156	9.5	68	19.7	76	36	378
SNS-181	3282	mst	65.20	0.71	15.44	5.63	0.05	2.69	1.32	0.35	4.00	0.11	4.70	100.22	617	76	77	20	16	37	27	203	15.1	61	17.8	100	30	252
SNS-180	3325	mst	69.20	0.69	13.74	4.90	0.02	2.28	1.25	0.46	3.37	0.08	3.87	99.86	561	76	74	16	16	35	39	179	11.5	41	17.4	94	29	259
SNS-179	3360	mst	60.90	0.67	14.07	4.90	0.05	3.01	3.56	0.56	3.20	0.08	8.86	99.85	511	74	59	18	15	34	26	174	12.6	170	17.0	92	28	228
SNS-178	3330	f sst	58.70	0.67	12.08	4.61	0.06	2.83	7.12	1.13	3.35	0.14	8.31	98.98	587	74	57	14	16	26	23	157	12.6	172	16.5	71	30	319
SNS-177	3347	f sst	71.68	0.32	7.15	2.51	0.04	1.27	6.89	0.84	1.66	0.06	6.63	99.03	295	43	34	5	8	14	9	95	7.5	48	8.7	44	15	121
SNS-176	3334	mst	66.80	0.76	15.20	5.62	0.05	2.15	1.05	0.68	3.60	0.07	4.16	100.13	587	80	79	20	17	37	27	192	12.5	56	18.3	111	31	237
SNS-175	3272	mst	61.06	0.73	16.71	6.82	0.07	3.29	1.20	0.70	4.01	0.13	5.32	100.03	680	74	90	21	16	41	27	200	16.5	79	18.0	113	28	192
SNS-174	3235	mst	63.14	0.78	15.59	5.90	0.03	2.55	1.68	0.84	3.91	0.10	5.32	99.85	726	81	80	19	18	42	28	218	15.3	97	18.1	99	34	245
SNS-172	3219	mst	50.86	0.66	14.07	5.63	0.09	4.13	8.13	0.53	4.02	0.14	10.97	99.22	551	71	68	19	15	37	29	176	10.2	86	16.5	98	32	184
SNS-171	3212	mst	65.75	0.82	15.99	6.40	0.01	1.87	0.90	0.30	3.43	0.04	4.81	100.32	524	80	99	20	18	44	27	233	16.7	56	17.6	115	31	218

Table 2. (ctd)

SaNr	Metres	Lith	SiO_2	TiO_2	Al_2O_3	Fe_2O_{3T}	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total	Ba	Ce	Cr	Ga	Nb	Ni	Pb	Rb	Sc	Sr	Th	V	Y	Zr
Dobata Formation (ctd)																												
SNS-170	3195	f sst	65.51	0.71	15.96	5.97	0.05	2.76	0.74	0.32	4.09	0.12	4.19	100.42	644	74	83	20	17	41	31	218	11.8	66	17.7	111	28	210
SNS-169	3188	mst	76.83	0.67	11.10	4.08	0.09	0.94	0.69	0.23	2.06	0.02	3.20	99.92	394	95	54	12	16	23	26	126	9.5	34	17.3	71	31	383
SNS-168	3175	mst	66.62	0.82	15.90	5.52	0.05	1.67	1.35	0.32	3.37	0.08	4.61	100.30	566	97	77	21	20	38	34	175	15.3	49	20.1	106	35	280
SNS-167	3150	mst	65.73	0.87	18.40	4.80	0.04	1.44	0.41	0.24	3.31	0.03	5.13	100.39	571	98	87	25	21	43	30	202	15.8	40	22.2	122	39	255
SNS-166	3031	mst	60.12	0.68	18.18	6.96	0.02	2.61	0.59	0.33	4.36	0.08	6.19	100.12	657	76	92	24	15	48	33	233	16.4	54	18.3	119	32	166
Surai Khola Formation																												
SNS-165	3113	f sst	58.43	0.80	19.56	6.97	0.03	3.90	0.38	1.95	4.82	0.08	3.38	100.30	909	58	124	31	14	44	19	204	17.7	60	14.2	163	24	249
SNS-164	3098	f sst	61.33	0.74	18.72	6.92	0.03	2.83	0.71	0.31	3.92	0.07	5.27	100.85	648	78	88	27	16	47	35	206	15.1	67	19.3	125	28	157
SNS-163	3063	mst	65.35	0.73	13.78	5.99	0.03	2.09	1.46	0.72	3.43	0.48	6.04	100.11	635	89	75	17	17	36	14	189	10.4	79	17.7	93	40	300
SNS-162	3035	mst	61.32	0.75	18.41	6.94	0.03	2.84	0.53	0.22	4.74	0.08	4.68	100.54	704	72	92	25	17	47	40	239	17.6	84	20.0	118	32	138
SNS-161	3025	f sst	68.86	0.81	16.03	4.95	0.03	1.43	0.37	0.33	3.32	0.03	3.98	100.14	597	105	76	21	19	36	40	174	14.4	68	20.2	104	36	276
SNS-160	2986	f sst	76.58	0.76	11.72	3.20	0.02	1.38	0.73	0.55	2.18	0.02	2.94	100.08	491	117	55	12	17	24	18	123	8.9	54	20.9	73	39	542
SNS-159	2983	mst	71.19	0.72	14.27	4.81	0.03	1.86	0.72	1.05	2.63	0.02	3.46	100.75	538	102	66	18	18	30	22	144	11.0	63	20.0	89	36	358
SNS-158	2980	m sst	63.63	0.39	7.02	2.50	0.09	2.23	10.29	0.45	1.54	0.10	10.41	98.65	295	54	29	5	10	11	18	79	5.6	121	10.9	36	25	191
SNS-157	2917	mst	71.61	0.63	12.84	5.63	0.02	1.78	0.49	0.67	3.24	0.17	3.20	100.28	508	96	59	15	16	24	23	163	11.9	52	18.9	84	36	302
SNS-156	2888	f sst	68.63	0.42	6.45	3.20	0.10	2.91	7.07	0.58	1.32	0.08	8.70	99.45	207	53	30	4	11	9	10	67	6.9	53	9.9	35	25	146
SNS-155	2820	f sst	49.26	0.71	15.29	6.45	0.07	5.39	6.34	0.67	4.61	0.11	10.66	99.56	585	63	89	20	15	42	32	203	15.1	73	17.6	109	27	159
SNS-232	2768	m sst	74.16	0.43	9.05	3.34	0.04	1.92	3.55	0.44	1.97	0.09	4.74	99.72	351	60	34	9	11	16	15	110	6.9	94	11.6	38	22	178
SNS-231	2754	mst	60.51	0.73	14.34	4.83	0.04	2.29	5.03	0.25	3.76	0.09	7.40	99.28	562	87	69	19	18	31	31	178	12.4	70	19.5	82	30	230
SNS-154	2670	f sst	46.77	0.55	11.42	4.99	0.08	3.66	12.59	0.53	3.43	0.13	14.80	98.95	527	68	57	14	12	28	20	153	9.4	176	14.8	71	26	176
SNS-153	2594	f sst	57.96	0.77	14.60	5.62	0.04	3.00	5.01	0.27	4.02	0.12	8.06	99.48	557	82	78	20	19	39	36	189	13.1	97	19.5	109	34	226
SNS-152	2495	m sst	50.39	0.65	9.93	3.10	0.07	1.65	14.93	1.82	3.55	0.14	12.54	98.76	567	86	36	11	13	11	15	123	6.6	153	17.6	44	36	344
SNS-151	2416	f sst	62.39	0.28	5.66	2.34	0.12	1.09	13.36	0.39	1.34	0.07	11.54	98.58	203	42	18	3	7	9	11	73	4.3	64	8.9	21	20	126
SNS-150	2394	f sst	42.19	0.74	13.51	5.16	0.12	2.69	15.41	0.92	4.61	0.14	13.99	99.47	681	56	72	20	16	25	36	198	12.2	174	15.8	83	27	144
SNS-148	2344	f sst	53.75	0.81	16.46	6.17	0.06	3.37	5.89	0.28	4.27	0.11	8.70	99.87	585	81	78	23	18	43	37	199	13.1	142	20.3	101	37	167
SNS-147	2337	m sst	74.69	0.57	10.11	4.11	0.03	1.68	1.81	0.65	2.19	0.07	3.76	99.68	375	66	52	12	14	26	21	123	9.5	52	12.3	66	24	215
SNS-146	2317	f sst	58.61	0.80	14.34	4.50	0.03	2.21	6.34	0.55	3.67	0.10	8.21	99.37	626	84	69	19	18	32	31	171	11.9	104	19.2	100	32	248
SNS-145	2278	f sst	69.99	0.68	14.35	5.02	0.02	1.94	0.36	0.60	3.74	0.03	3.36	100.10	540	87	61	17	17	29	24	201	12.7	38	20.4	91	34	269
SNS-144	2249	mst	69.98	0.56	9.16	4.46	0.04	1.92	4.59	0.96	2.10	0.09	5.65	99.51	381	66	37	12	13	22	17	111	7.4	83	12.6	65	23	274
SNS-143	2220	mst	70.73	0.67	13.68	5.52	0.03	1.85	0.29	0.57	3.29	0.05	3.43	100.11	546	80	66	18	16	29	22	170	12.4	48	18.2	88	28	232
SNS-142	2211	m sst	55.22	0.46	4.42	2.77	0.28	1.32	17.09	0.49	0.95	0.09	14.79	97.88	166	62	23	2	11	7	10	49	6.0	127	10.7	35	26	220
SNS-141	2163	mst	50.22	0.67	13.51	4.40	0.08	3.17	10.27	0.58	4.16	0.11	11.65	98.82	601	64	65	19	16	31	28	190	12.0	106	17.3	94	29	176
SNS-140	2140	f sst	61.27	0.65	11.95	4.93	0.05	2.26	6.17	1.35	3.20	0.14	7.31	99.28	585	88	56	16	15	30	29	151	10.5	114	19.0	78	33	314
SNS-139	3096	f sst	51.03	0.73	14.75	6.28	0.07	3.17	7.92	0.76	4.52	0.10	10.07	99.43	713	72	75	22	17	33	32	201	12.6	119	18.2	96	34	149
SNS-138	2080	mst	59.93	0.79	19.30	6.35	0.03	2.93	0.47	0.36	5.37	0.07	4.65	100.24	711	78	100	27	19	49	50	278	17.8	51	21.1	141	38	174
SNS-100	2075	mst	55.27	0.65	17.05	6.14	0.05	3.02	4.21	0.60	4.84	0.11	7.96	99.91	671	62	79	25	14	42	43	231	13.5	78	18.4	108	29	137
SNS-99	2071	mst	54.43	0.72	21.58	6.68	0.03	4.19	0.60	0.75	5.67	0.06	5.60	100.30	850	53	102	32	18	44	28	296	20.1	42	16.8	123	22	156
SNS-98	2045	mst	47.34	0.71	15.40	5.35	0.12	3.32	10.39	0.58	4.71	0.09	11.81	99.81	605	62	82	23	17	33	35	218	12.8	109	17.6	101	31	148
SNS-97	2031	f sst	63.72	0.85	17.89	5.76	0.02	2.22	0.31	0.90	4.69	0.02	3.92	100.29	729	75	92	25	19	32	25	255	18.1	64	20.6	120	28	221
SNS-96	2025	f sst	61.41	0.51	7.90	3.42	0.07	1.62	10.63	0.94	2.09	0.12	10.05	98.75	357	81	34	8	13	18	20	102	7.1	121	14.3	46	29	366
SNS-95	2018	f sst	67.23	0.77	16.10	5.54	0.02	1.91	0.31	0.86	3.94	0.02	3.50	100.19	784	101	83	22	18	40	38	208	14.8	60	21.1	107	40	306
SNS-94	1985	f sst	62.41	0.83	18.25	5.84	0.03	2.31	0.45	0.96	4.94	0.02	3.99	100.02	859	73	97	28	20	37	67	222	15.8	47	20.7	116	35	206
SNS-93	1975	f sst	64.27	0.57	9.15	3.44	0.04	1.68	8.15	1.23	2.31	0.15	8.11	99.09	423	96	43	9	14	19	20	105	5.9	107	18.9	48	31	406
SNS-92	1932	f sst	48.86	0.69	15.88	6.07	0.07	3.58	8.06	0.82	4.98	0.13	10.89	100.04	640	62	79	23	16	35	29	210	14.4	96	16.5	111	32	143
SNS-91	1901	f sst	76.36	0.70	11.36	4.07	0.01	1.14	0.45	0.68	2.72	0.02	2.64	100.17	522	79	56	14	16	21	16	157	10.3	74	17.3	69	27	286
SNS-90	1860	m sst	72.13	0.43	7.46	2.19	0.04	1.10	6.50	1.25	1.76	0.08	6.17	99.10	364	71	29	7	11	17	17	86	7.5	95	12.5	37	22	335
SNS-89	1818	m sst	68.95	0.34	7.55	2.50	0.08	1.39	7.83	0.96	1.74	0.08	7.69	99.10	313	51	28	6	9	12	19	92	6.4	135	10.6	26	23	140

Table 2. (ctd)

SaNr	Metres	Lith	SiO_2	TiO_2	Al_2O_3	Fe_2O_{3T}	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total	Ba	Ce	Cr	Ga	Nb	Ni	Pb	Rb	Sc	Sr	Th	V	Y	Zr
Chor Khola Formation																												
Shivgarhi Member																												
SNS-88	1760	f sst	49.04	0.61	13.08	5.25	0.14	2.97	10.87	0.88	4.03	0.21	11.94	99.01	570	62	61	18	14	29	31	170	11.4	107	16.3	88	31	169
SNS-87	1752	f sst	61.75	0.85	18.25	5.61	0.02	2.15	1.03	0.65	5.35	0.03	4.56	100.23	756	86	96	27	20	38	30	252	19.5	44	23.0	121	37	211
SNS-86	1732	m sst	79.72	0.44	7.93	2.97	0.06	1.00	1.89	1.22	1.54	0.09	2.89	99.74	288	60	35	8	10	14	16	94	4.6	49	12.7	39	28	194
SNS-85	1683	f sst	50.86	0.68	16.36	6.39	0.09	2.86	7.14	1.51	4.99	0.12	8.91	99.91	799	59	86	26	17	37	30	206	14.1	96	17.4	115	29	156
SNS-84	1645	mst	72.32	0.74	13.19	4.43	0.03	1.33	0.89	0.58	2.82	0.05	3.58	99.94	631	82	64	17	18	29	28	154	9.7	51	17.5	88	29	259
SNS-83	1633	f sst	55.00	0.54	7.67	2.25	0.12	1.02	15.43	1.47	1.87	0.18	12.97	98.52	351	85	34	42	12	12	19	83	4.0	123	19.5	33	35	284
SNS-82	1560	mst	58.41	0.67	13.79	5.51	0.05	2.51	6.05	1.43	3.51	0.12	7.47	99.52	620	72	83	20	16	35	25	148	11.5	98	17.7	95	29	238
SNS-81	1556	mst	53.71	0.55	9.51	3.41	0.08	2.49	12.51	0.80	2.68	0.10	12.73	98.56	389	64	46	12	12	21	21	113	9.6	132	14.1	52	28	253
SNS-80	1547	mst	41.25	0.61	12.04	4.67	0.12	2.65	17.14	0.36	4.30	0.09	16.15	99.36	481	52	63	17	13	30	39	171	8.3	102	16.4	75	26	100
SNS-79	1536	f sst	61.95	0.53	8.96	3.94	0.09	1.72	9.25	1.22	2.28	0.11	9.27	99.34	424	62	47	11	13	19	20	104	5.7	121	14.6	53	27	250
SNS-78	1519	mst	64.44	0.87	16.78	5.76	0.01	2.50	0.45	1.08	4.60	0.07	3.65	100.22	743	77	88	25	20	40	26	243	16.4	41	21.2	110	22	208
SNS-77	1470	f sst	43.26	0.60	10.47	3.48	0.16	2.07	18.10	0.97	3.19	0.13	16.15	98.58	495	59	51	14	13	21	42	133	7.0	170	16.6	59	31	180
SNS-76	1435	m sst	52.27	0.32	4.25	1.51	0.08	0.89	20.30	0.55	0.89	0.05	16.63	97.74	178	51	26	3	7	13	24	43	2.9	219	8.3	12	22	168
SNS-75	1397	m sst	68.06	0.40	5.50	2.77	0.07	2.43	8.08	0.73	1.31	0.08	9.40	98.83	234	65	26	4	9	12	19	63	3.3	63	11.7	39	20	247
SNS-74	1374	f sst	47.41	0.44	9.49	3.92	0.14	4.24	13.74	0.91	3.10	0.13	15.32	98.84	401	58	42	12	11	29	32	130	8.3	119	12.1	62	23	156
SNS-73	1345	mst	65.96	0.82	17.12	5.41	0.02	1.69	0.45	0.61	4.49	0.05	3.83	100.45	739	87	87	24	20	44	40	223	15.4	55	22.2	119	34	246
SNS-72	1324	f sst	49.60	0.57	8.66	3.71	0.10	1.90	15.89	0.93	2.43	0.10	14.51	98.41	425	66	43	11	13	20	18	104	6.1	231	14.3	46	26	277
SNS-71	1305	f sst	60.52	0.70	11.51	3.72	0.03	2.01	7.88	0.83	2.91	0.09	9.03	99.23	482	75	56	14	16	23	27	133	11.3	139	17.0	68	26	253
SNS-70	1289	f sst	70.48	0.74	13.51	4.75	0.02	1.72	0.84	1.26	3.10	0.08	3.42	99.92	579	83	66	17	19	31	29	152	9.9	78	19.6	90	29	283
SNS-69	1280	mst	54.81	0.73	13.83	4.68	0.05	2.92	7.69	0.91	3.92	0.11	9.62	99.26	595	93	67	19	15	29	44	159	10.2	95	20.7	85	34	242
SNS-68	1265	mst	64.07	0.77	17.26	6.46	0.03	1.83	0.30	0.76	4.38	0.05	4.08	99.99	768	86	85	25	19	37	31	209	15.5	97	20.7	115	37	245
SNS-67	1243	mst	81.70	0.66	9.10	2.55	0.01	0.91	0.26	1.05	1.92	0.12	1.77	100.05	361	112	39	9	16	16	19	91	6.3	50	19.8	63	32	559
SNS-66	1238	mst	65.48	0.49	6.81	2.43	0.05	1.33	9.96	0.89	1.52	0.09	9.52	98.57	299	60	25	5	11	12	15	74	4.9	148	12.7	38	21	304
SNS-65	1258	mst	60.98	0.63	12.31	4.63	0.05	2.05	6.54	1.46	2.98	0.11	7.74	99.47	546	70	57	17	15	25	22	128	9.7	117	15.9	82	25	264
SNS-64	1270	mst	66.89	0.48	6.68	2.92	0.05	1.24	9.16	0.70	1.49	0.07	9.14	98.80	288	67	31	6	12	15	17	74	6.7	145	12.2	41	22	277
SNS-63	1217	f sst	58.08	0.82	16.77	4.55	0.04	2.58	4.34	2.28	4.46	0.13	5.64	99.69	914	62	80	26	20	27	20	196	14.7	179	17.0	92	21	219
SNS-62	1205	mst	66.37	0.79	15.89	6.45	0.03	1.71	0.25	0.89	3.78	0.04	3.79	100.00	753	80	78	22	19	36	37	200	13.5	93	19.8	110	31	254
SNS-61	1187	mst	55.63	0.65	14.92	5.43	0.07	2.62	6.33	0.96	4.54	0.12	8.34	99.60	688	70	75	21	17	32	37	194	13.0	109	17.7	101	30	197
SNS-60	1185	mst	42.87	0.73	11.44	5.24	0.18	3.20	15.19	0.37	3.29	0.14	16.11	98.75	490	72	66	15	18	33	47	128	8.8	194	18.1	80	26	168
SNS-59	1180	mst	47.45	0.73	13.84	5.12	0.12	2.38	12.21	0.49	3.78	0.12	13.01	99.24	506	77	74	19	17	32	54	159	11.8	184	18.6	89	33	155
SNS-58	1154	f sst	59.50	0.57	8.63	2.99	0.04	1.67	10.98	0.76	2.24	0.09	10.94	98.41	373	74	45	7	14	17	19	97	6.4	167	16.1	48	25	303
SNS-57	1135	f sst	58.60	0.66	10.89	3.78	0.04	2.27	8.86	0.66	2.71	0.08	10.56	99.11	418	71	52	14	16	21	22	116	8.8	138	15.5	70	25	223
SNS-56	1127	f sst	67.19	0.53	7.76	2.85	0.07	1.30	8.13	0.98	1.67	0.11	7.95	98.55	312	63	36	7	12	17	15	97	5.5	133	13.2	46	21	276
SNS-54	1086	mst	61.07	0.82	17.57	7.14	0.03	2.05	1.12	0.46	4.22	0.05	5.70	100.22	689	86	94	26	20	33	34	212	16.5	107	20.5	124	30	205
SNS-53	1075	mst	73.19	0.61	12.44	4.34	0.01	1.87	0.28	1.11	3.20	0.11	2.55	99.70	546	71	53	15	14	31	24	153	11.1	40	16.8	74	24	234
SNS-52	1037	mst	66.65	0.79	16.28	5.98	0.01	1.41	0.45	0.52	3.73	0.04	4.20	100.05	663	78	84	21	20	37	26	203	16.0	67	19.9	111	31	245
SNS-51	1021	f sst	47.85	0.59	14.47	4.93	0.23	4.45	9.25	0.75	4.74	0.15	12.10	99.53	549	55	63	19	15	21	46	196	14.4	92	14.7	93	33	139
SNS-50	1010	mst	68.59	0.51	7.66	2.92	0.02	2.15	6.57	0.80	1.63	0.08	8.10	99.05	287	64	36	6	12	15	10	82	7.1	90	13.6	42	19	300
SNS-49	1000	mst	73.84	0.45	5.14	2.39	0.03	1.32	6.84	0.44	0.98	0.08	7.36	98.88	184	63	32	3	12	11	12	54	3.6	96	10.2	31	20	252
Jungli Khola Member																												
SNS-48	980	mst	46.20	0.51	8.88	3.23	0.08	3.17	16.32	0.49	2.76	0.08	16.47	98.17	401	54	42	9	13	19	28	110	5.8	128	14.9	47	23	160
SNS-47	962	f sst	73.32	0.65	12.71	4.16	0.01	1.40	0.38	0.99	3.44	0.03	2.69	99.78	592	81	60	15	15	30	20	154	10.8	45	17.8	82	31	294
SNS-46	932	f sst	63.18	0.62	8.48	2.55	0.03	1.73	9.05	0.84	1.98	0.11	9.68	98.23	312	92	48	8	15	16	16	86	6.3	134	17.8	47	28	462
SNS-45	912	mst	64.09	0.75	17.87	5.68	0.01	1.79	0.40	0.53	4.43	0.04	4.31	99.90	656	99	90	23	18	41	41	225	15.2	87	21.6	121	27	191
SNS-44	892	f sst	65.65	0.47	7.43	2.74	0.04	1.51	9.23	0.80	1.63	0.08	9.14	98.73	314	62	34	8	11	18	16	74	6.5	101	12.1	43	19	229

Table 2. (ctd)

SaNr	Metres	Lith	SiO_2	TiO_2	Al_2O_3	Fe_2O_{3T}	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	Total	Ba	Ce	Cr	Ga	Nb	Ni	Pb	Rb	Sc	Sr	Th	V	Y	Zr
Jungli Khola Member (ctd)																												
SNS-43	872	m sst	58.27	0.37	4.56	2.30	0.06	2.11	14.49	0.20	1.02	0.07	14.30	97.74	166	59	26	n.d.	9	10	22	49	5.7	154	12.7	28	18	189
SNS-42	863	mst	59.27	0.62	13.05	4.89	0.08	3.00	5.79	0.79	3.62	0.12	8.15	99.39	627	69	62	17	16	32	22	161	13.5	73	16.1	82	27	191
SNS-41	853	f sst	52.85	0.69	16.17	6.47	0.08	3.18	5.71	0.29	4.60	0.10	9.35	99.49	703	77	73	21	17	36	28	203	14.8	106	21.0	107	34	141
SNS-40	848	f sst	49.34	0.36	6.08	2.39	0.15	1.29	19.19	0.90	1.55	0.09	16.32	97.65	335	55	22	4	9	12	64	67	3.5	194	10.3	23	33	182
SNS-39	838	mst	53.20	0.80	18.79	6.27	0.06	2.46	4.85	0.40	4.61	0.12	8.31	99.86	679	86	99	30	19	43	38	191	16.4	112	22.1	135	32	152
SNS-38	830	f sst	57.12	0.72	17.02	6.15	0.04	2.93	3.19	0.38	4.72	0.11	7.07	99.45	638	85	87	23	18	41	23	212	16.8	63	20.7	103	34	163
SNS-37	815	m sst	76.62	0.44	3.46	2.06	0.05	1.35	6.48	0.31	0.83	0.05	6.85	98.51	162	61	20	1	9	8	7	45	4.4	64	8.1	26	17	328
SNS-36	793	mst	72.47	0.70	13.03	4.80	0.02	1.36	0.27	1.15	3.39	0.03	2.45	99.65	694	89	63	15	16	32	36	164	12.5	38	18.3	81	33	292
SNS-35	790	mst	75.26	0.77	12.87	3.06	0.00	1.10	0.15	0.44	3.51	0.03	2.54	99.72	568	105	64	16	19	21	32	185	10.7	50	19.2	90	30	417
SNS-34	777	mst	61.85	0.56	11.02	4.36	0.12	2.10	6.91	0.90	2.69	0.12	8.22	98.83	650	56	66	13	13	27	35	119	11.9	96	14.5	79	30	178
SNS-33	770	m sst	70.59	0.30	4.88	1.85	0.04	1.47	8.74	0.36	1.19	0.05	9.02	98.48	206	44	23	3	7	10	10	54	4.1	92	8.1	25	15	144
SNS-32	760	m sst	68.06	0.47	6.91	2.26	0.03	1.31	8.67	0.61	1.61	0.09	8.64	98.66	278	69	34	5	11	15	15	76	5.9	90	13.0	43	20	302
SNS-31	748	f sst	55.45	0.44	5.41	1.84	0.22	1.17	16.77	0.47	1.37	0.07	14.65	97.87	243	64	27	4	10	12	58	60	5.0	152	10.2	27	23	261
SNS-30	736	mst	56.01	0.87	15.46	6.86	0.04	2.46	4.99	0.43	3.69	0.14	8.32	99.27	533	95	88	22	20	38	29	161	14.2	113	20.6	115	34	195
SNS-29	727	mst	72.99	0.76	13.52	4.69	0.01	1.02	0.21	0.43	3.37	0.05	3.10	100.16	540	93	81	17	18	38	26	162	10.9	51	19.7	91	31	322
SNS-28	712	mst	77.54	0.47	7.60	3.15	0.04	0.86	3.07	0.70	1.75	0.03	4.07	99.26	334	70	33	7	11	17	32	86	7.2	55	12.9	41	25	225
SNS-27	636	m sst	87.96	0.45	4.92	1.66	0.02	0.70	0.59	0.53	0.97	0.07	1.40	99.27	187	69	22	2	9	9	7	53	3.4	23	10.6	30	22	341
SNS-26	592	f sst	68.28	0.47	7.81	3.06	0.03	1.52	7.44	0.67	1.78	0.08	7.92	99.06	305	59	29	7	12	17	18	95	7.3	119	13.8	35	22	262
Bankas Formation																												
SNS-25	580	m sst	76.43	0.21	4.05	1.27	0.03	1.05	6.73	0.42	0.87	0.04	7.59	98.67	170	42	14	1	6	6	12	50	3.1	79	5.9	16	12	100
SNS-24	560	mst	47.02	0.72	12.56	5.78	0.06	2.79	12.39	0.26	3.11	0.11	14.08	98.89	406	87	70	15	18	30	32	128	11.3	165	21.4	92	30	192
SNS-23	550	mst	63.14	0.79	18.54	5.71	0.02	2.30	0.25	0.26	4.76	0.10	4.30	100.16	769	86	102	27	19	47	22	226	15.0	61	20.3	119	31	188
SNS-20	514	mst	65.31	0.71	17.79	4.29	0.01	2.02	0.12	0.36	5.01	0.05	3.97	99.64	851	71	98	26	13	43	58	240	14.2	44	20.2	116	44	184
SNS-19	500	mst	61.06	0.78	17.33	4.67	0.02	2.17	2.83	0.26	4.69	0.07	5.92	99.80	750	81	89	26	18	46	29	213	14.4	58	20.4	113	27	193
SNS-18	471	f sst	62.37	0.62	7.85	2.73	0.04	1.93	10.07	0.43	1.96	0.11	10.66	98.77	311	72	49	8	18	20	21	88	6.8	112	14.8	48	25	222
SNS-17	449	mst	79.60	0.69	11.10	2.02	0.00	0.78	0.14	0.53	2.49	0.02	2.28	99.65	495	83	49	12	17	17	25	137	9.5	30	17.5	64	22	319
SNS-16	430	f sst	70.77	0.64	13.12	5.82	0.16	1.21	0.39	0.32	3.47	0.03	4.43	100.35	551	94	59	17	15	26	33	171	10.8	38	17.6	88	29	262
SNS-15	402	f sst	79.20	0.54	8.95	3.17	0.02	1.12	1.00	0.66	2.15	0.15	2.38	99.34	370	94	38	8	13	19	13	107	5.1	39	16.1	52	25	336
SNS-14	358	m sst	72.77	0.37	3.26	1.64	0.06	1.01	9.45	0.36	0.74	0.05	8.81	98.53	155	63	16	n.d.	8	7	12	41	3.2	83	8.8	19	18	379
SNS-13	347	f sst	62.72	0.62	11.30	4.07	0.07	1.70	6.91	0.69	2.86	0.10	7.89	98.94	512	76	54	12	15	24	19	129	8.3	78	17.2	73	29	253
SNS-12	330	f sst	51.19	0.61	9.52	4.56	0.18	1.97	14.02	0.49	2.48	0.14	13.71	98.88	401	73	47	12	15	20	32	111	7.8	129	15.0	63	27	257
SNS-11	312	f sst	62.84	0.46	6.63	2.68	0.15	1.68	10.98	0.59	1.60	0.10	10.72	98.42	273	63	30	4	10	16	34	72	5.2	93	14.0	40	21	272
SNS-9	256	f sst	59.35	0.60	12.77	4.94	0.05	2.50	6.42	0.54	3.63	0.10	8.45	99.34	590	67	63	17	14	28	19	157	11.1	76	15.6	72	24	169
SNS-8	252	f sst	52.69	0.51	10.83	3.93	0.10	2.52	11.82	0.55	3.23	0.10	12.64	98.91	554	52	46	15	13	20	30	132	9.5	114	12.3	56	25	140
SNS-7	190	f sst	57.20	0.52	8.34	2.76	0.19	1.04	14.38	0.29	2.38	0.09	12.75	99.95	326	64	47	8	13	16	35	96	9.2	94	14.8	47	25	199
SNS-6	174	f sst	83.50	0.54	7.86	2.96	0.01	0.84	0.16	0.66	1.66	0.07	1.73	99.97	287	81	37	7	13	17	12	89	4.8	31	14.4	59	30	326
SNS-5	34	m sst	83.47	0.52	7.06	1.23	0.01	0.63	1.71	0.69	1.34	0.06	2.75	99.48	207	103	28	6	12	14	12	67	5.0	44	17.5	37	23	569
SNS-4	19	m sst	72.04	0.37	5.46	1.80	0.02	1.04	8.02	0.47	1.00	0.06	8.08	98.36	173	61	23	4	10	14	9	52	5.6	103	10.8	33	17	217
SNS-2	6	m sst	70.86	0.59	11.69	4.14	0.08	1.38	2.87	0.72	2.08	0.31	5.35	100.06	374	66	49	14	15	26	33	118	11.1	60	14.6	68	22	209
SNS-1	4	m sst	52.71	0.62	9.64	2.53	0.09	1.73	14.32	0.58	2.33	0.09	13.61	98.25	379	67	48	12	15	18	32	102	7.8	141	14.4	54	24	279

Table 3. Average sandstone (S) and mudstone (M) compositions, Siwalik Group, Surai Khola section. n = number of samples.

Fmtn	Bankas		Chor Khola		Surai Khola		Dobata		Dhan Khola	
Lithology	S	M	S	M	S	M	S	M	S	M
n	16	5	31	31	29	12	14	18	6	14
Major elements (wt%)										
SiO_2	66.88	63.23	60.90	62.73	61.74	61.49	69.71	64.34	70.83	66.33
TiO_2	0.52	0.74	0.55	0.67	0.64	0.69	0.61	0.75	0.64	0.67
Al_2O_3	8.65	15.46	9.68	12.76	12.31	15.28	12.17	15.49	13.25	13.99
Fe_2O_3T	3.14	4.49	3.51	4.67	4.53	5.59	4.25	5.41	4.97	4.39
MnO	0.08	0.02	0.08	0.05	0.06	0.04	0.04	0.05	0.06	0.04
MgO	1.46	2.01	1.97	1.98	2.31	2.61	1.67	2.19	1.63	1.78
CaO	7.45	3.15	9.10	5.28	6.17	3.25	2.79	2.03	1.18	3.13
Na_2O	0.53	0.34	0.84	0.74	0.77	0.61	0.59	0.44	0.42	0.38
K_2O	2.11	4.01	2.56	3.28	3.19	3.99	2.75	3.57	2.98	3.09
P_2O_5	0.10	0.07	0.10	0.08	0.09	0.12	0.09	0.07	0.09	0.09
LOI	8.22	6.11	9.65	7.24	7.73	6.29	5.02	5.65	3.98	5.72
Total	99.14	99.63	98.92	99.48	99.53	99.97	99.69	99.97	100.01	99.61
Trace elements (ppm)										
Ba	352	654	419	547	524	609	489	575	484	476
Ce	71	81	67	77	74	76	75	84	76	81
Cr	41	82	47	65	60	74	60	77	64	66
Ga	10	21	13	17	16	21	15	20	16	16
Nb	13	17	13	16	15	16	15	17	15	16
Ni	18	37	20	29	27	35	29	38	32	33
Pb	22	33	25	30	26	29	24	31	27	27
Rb	99	189	116	153	153	201	149	190	161	160
Sc	7	13	8	11	11	13	11	14	12	12
Sr	82	72	116	94	95	72	66	63	38	50
Th	14	20	15	18	16	18	16	19	16	17
V	51	101	58	84	78	99	77	102	85	83
Y	23	31	26	28	29	31	28	32	31	31
Zr	262	215	235	243	238	219	240	248	217	233

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