

Appendix A-Outcrops

Coordinates in NZTM, WGS 84

Outcrop	Easting	Northing	Outcrop description	Foliation		Lineation		Other orientations		
				Azimuth	dip	Azimuth	dip	Azimuth	Dip	
<i>Bullendale</i>										
B1	1257733	5031784	Nothing in situ. Boulders in the creek.	-	-	-	-	-	-	
B2	1257733	5031783	Foliation and lineation are folded by Moonlight fold generation. Rock has segregation layers. Veins are N-S trending.	270	38	285	36	Fold hinge	348	2
				265	35			Vein orientation	250	38
				270	36			Vein/ fault orientation	70	60
								Kinks	180	0
									70	60
B3	1257781	5031628	The main foliation is dipping shallowly to the SE and is bend around a shallowly SW dipping fold axis. There are conjugate joints with ankerite-bearing veins and a shallowly to the W dipping fault. A couple of metres down the stream are abundant kink folds.	150	35	90	20	Fault and vein orientation (BUL3A)	294	38
				198	30	108	8	"Conj." vein orientation pair 1	108	80
				270	12			"Conj." vein orientation pair 1	130	90
								"Conj." vein orientation pair 2	262	84
								"Conj." vein orientation pair 2	296	64
								Little vein (BUL3B)	303	90
B4	1257904	5031533	Altered schist with fault zone.					Kink fold axis	225	20
				270	35	292	30	Fault zone	42	80
								Fault zone	238	48
								Vein orientation	72	80
								Vein in fault zone	66	64
<i>Copper Creek</i>										
C1	1254407	5030890	Copper Creek Fault. Several cm thick silicified fault breccias (fault #4) separating cataclastic fault zone (about 2 m wide) in the foot wall and a highly altered schist in the hanging wall. In the foot wall also stibnite-bearing fault breccias (#1, 2, 3), which are cut by faults with striations.	304	46			Silicified fault breccia separating altered schist from brecciated, sheared schist (4)	4	72
				304	45			Striae on fault (4)	294	54
				308	25			Fold hinge	200	17
				278	38			Fold hinge	33	15
				295	65			Kink fold hinge	334	45
				264	35			Fault with ankerite	200	66
				326	50			Fault with ankerite	24	38
				91	55			Silicified Sb-breccia (2)	325	75
				250	30			Fault cutting across Sb-bearing faults (2)	252	70
				296	51			Striae on fault (2)	284	64
								Silicified Sb-breccia (1)	290	80
								Fault cutting across Sb-bearing faults (1)	201	80
								Striae on fault (1)	278	73
								Stibnite-bearing silicified breccia (3)	326	70
								Little faults in Sb-bearing fault (3)	348	78
C2	1254338	5030950	Crosscutting veins: N-S and NW-SE trending veins. The N-S trending veins have ankerite rims, the others do not. FA of kink folds dips shallowly to the S.					Vein	290	88
								Qtz-carb veins	198	42

Outcrop	Easting	Northing	Outcrop description	Azimuth	dip	Azimuth	dip		Azimuth	Dip
C3	1254433	5030864	Greyschist with kink folds with ankerite along the foliation and in veins. On the S facing slope is the Copper Creek fault zones with silicified breccia (max. 50 cm wide)	278	35			Crosscutting Qtz Veins	130	90
				160	65			Kink fold axis	208	32
								Fault zone	14	80
								Fault surface (3)	18	48
								Slickensides (3) (about)	12	55
C4	1254446	5030826	A c. 10-20 cm wide fault zone. Within the fault zone the foliation is rotated parallel to the fault surfaces.	255	35	258	35	fault	223	70
N1	1271535	5063155	Not in-situ block of diatreme breccia, some components up to 60 cm. Components are schist, "marble", metabasites, lamprophyre.							
N2a	1271515	5063200	Close to S' border of the diatreme. Lamprophyre dike in contact to schist breccia.							
N2b	1271503	5063173	In southern boundary of diatreme with several metre big blocks of greyschist. Here no lamprophyre dikes or components. Towards the centre of diatreme, components get smaller and are just a few cm or dm big. More lamprophyre dikes.							
N2c	1271459	5063197	Centre of diatreme. The diatreme breccia has components several dm big. Lots of bracken overgrowth.							
N3	1271388	5063227	Corner Dike in contact to Diatreme breccia. Some of the thinner dikes branch of the main dike and follow the steeply, N-dipping joints.					Contact diatreme- lamprophyre	5	75
N3b	1271339	5063254	Outside the diatreme on a grassy slope. Some small (~0.5 m ²) outcrops of greyschist and lamprophyre.	140	25					
<i>Mt Alta</i>										
A1	1280157	5065097	Silicified breccia with schist clasts and ankerite; 30-350 cm wide; joints cut at least the schist and are sometimes covered in orange mineral (presumably replaced ankerite).					Silicified fault breccia	270	62
								Joint	10	90
A1.2	1280166	5065108	S end of diatreme, lamprophyre crosscutting schist along joint					Carbonate vein (very straight)	202	70
A1.3	1280166	5065108	A lamprophyre dike within the schist-dominated diatreme breccia, in centre of dike is a "vein" of the sparry carbonate					Carbonate impregnated surface	25	35

Outcrop	Easting	Northing	Outcrop description	Azimuth	dip	Azimuth	dip	Azimuth	Dip
A2	1280171	5065125	Lamprophyre sill in fine grained breccia (<1mm). Just a few metres on, breccia contains several dm big clasts. Carbonate veins crosscut the contact of breccia-lamprophyre. In the lamprophyre are several dm-big lenses rich in sparry carbonate.					Carbonate veins	80 90
A2.3	1280160	5065115	At outer rim of diatreame.						
AJ1	1280169	5065106	In diatreame						
AJ2	1280169	5065106	In diatreame						

Treble Cone & Black Peak area

T1	1271396	5049804	Adjacent to a scree covered fault is a roughly 30m wide ankeritic alteration halo. The intensity of alteration differs across foliation. The scree covering the fault comprises components made of silicified breccias and the rock close to the fault contains ankerite veins, occasionally with quartz in the centre. In the scree are also components of schist which are slightly kinked with ankerite veins striking parallel to the fold hinges but not the fold axial plane.	227 210	18 22			Vein orientation	30 45
T1.5	1271067	5051052	Outcrop with kink folds in mica-rich greyschist, might be in situ, but as it is so far down the slope this is not certain. Conjugate kink folds enclose an angle of roughly 40°. The schist has "rusty spots" due to weathering						
T2	1270409	5051825	Some ankeritic breccias and veined rocks in scree.						
T3	1269180	5052808	Several meter thick band of greenschist in greyschist with veins of very coarse grained quartz and Fe-carbonate.						
T4	1269201	5053871	Micaceous greenschist which is altered adjacent to a several meter wide fault zone. The fault zone strikes roughly 100 and dips about vertically. In scree are pieces of breccias and slightly kinked schist. Foliation dips shallowly (ca. 20°) towards the W					qtz-ankerite vein	10 80
T5	1269232	5052832	Greenschist with bands of Qtz-Fe carbonate veins, which are boudinaged. Fold hinges dip 14/5. The greenschist itself can contain chunky carbonate.						
T6	1269510	5052887	Greenschist with slight kink folds and related faults. Very subtle alteration with tiny veinlets following the foliation in the greenschist.	173	15			Kink fold axis	240 10
T7	1271499	5050792	Scree covered fault zone with altered greenschist N of it and altered greyschist south of it. In the greenschist, the alteration halo is around 3 m wide (includes green and greyschist). Joints striking N and ENE. Thick ankerite vein is cut by N-striking joints.						
T8	1272576	5049360	Greyschist with red staining following foliation. The staining fluid came in from the adjacent joint.					Joints	29 82
								Joints	28 80
								Joints	278 85
								Qtz vein	62 85
								Joint	350 68

Outcrop	Easting	Northing	Outcrop description	Azimuth	dip	Azimuth	dip		Azimuth	Dip
<i>Red Rock</i>										
RR1	1255962	5061015	The entire outcrop area is largely covered by scree, even on the ridge and especially where the altered rocks are. Unaltered rock on the other hand is in-situ on the ridge and foliation can be measured. Outcrop RR1-2 are outside the visible alteration halo. RR3-6 are within it. RR 7 is on the E boundary of it.	347	33					
RR2	1255985	5061038								
RR3	1255998	5061055								
RR4	1255994	5061124								
RR5	1256022	5061087								
RR6	1256075	5061086								
RR7	1256122	5061096								

Appendix B-Samples

MOst of these samples were examined for textural and mineralogical features in hand specimen and thin section.

SEM and MP were used for imaging and to obtain mineral chemistry.

Outcrop	Easting	Northing	Sample	Sample description	SEM/MP	TE in minerals	Whole Rock chemistry	Stable isotopes	Radiogenic isotopes	OU Number
B1	1257733	5031784	BUL-1	Silicified breccia, not in situ	Y			Y		85615
B2	1257733	5031783	BUL-2A	Altered greyschist	Y			Y		85616
			BUL-2B	Altered greyschist with fault breccia and veins	Y	Y		Y	Y	85617
			BUL-2C	Unaltered greyschist	Y		Y	Y	Y	85618
B3	1257781	5031628	BUL-3A	Thick carbonate vein in fault				Y		85619
			BUL-3B	Vein carbonate in joint				Y	Y	85620
			BUL-3C	Partly altered greenschist. Not in-situ		Y	Y	Y	Y	85621
B4	1257904	5031533	BUL-4A	Strongly sheared fault breccia				Y	Y	85622
			BUL-4B	SE-NW trending fault filled with veins						85623
			BUL-4C	Partly altered greenschist. Not in-situ	Y		Y	Y	Y	85624
C1	1254407	5030890	COP-1A	Silicified breccia from the contact of the cataclastic area and undeformed but altered schist	Y					85625
			COP-1B	From silicified, Sb-impregnated breccia						85626
			COP-1D	altered greenschist with fissure	Y					85627
			COP-2D	altered greenschist	Y					85628
C3	1254433	5030864	COP-2A	Greyschist with kink folds and ankerite alteration Veined breccia from Copper Creek Fault. One of the surfaces of the sample is a polished fault surface and the veins are above it.	Y					85629
			COP-2B		Y	Y		Y	Y	85630
			COP-2C	Silicified breccia from Copper Creek fault	Y	Y		Y	Y	85631
C4	1254446	5030826	COP-3A	Fault breccia				Y	Y	85632
N1	1271535	5063155	ND-1A	Marble with miarolitic cavity	Y	Y				85633
			ND-1B	Piece of diatreme breccia						85634
			ND-1D	Piece of diatreme breccia, with schist fragment, strongly altered	Y					85635

Outcrop	Easting	Northing	Sample	Sample description	SEM/MP	TE in minerals	Whole Rock chemistry	Stable isotopes	Radiogenic isotopes	OU Number
N2a	1271503	5063173	ND-2E	Greyschist						85637
N2a	1271459	5063197	ND-2A	Piece of diatreme breccia, from central part of diatreme, with marble component	(Y)					85638
			ND-2B	Marble-component from the breccia			Y			85639
N2c	1271388	5063227	ND-3A	Piece of diatreme breccia, from northern border of diatreme	Y					85641
			ND-3B	Lamprophyre from Corner Dike.			Y			85642
N3	1271339	5063254	ND-3C	Lamprophyre about 50 m away from diatreme, on grassy spur		Y		Y	Y	85643
N3b	1271339	5063254	ND-3D	Greyschist north of the diatreme						85644
A1	1280157	5065097	AD-1A	Centre of quartz reef						85645
			AD-1B	Contact of quartz reef to greyschist	Y	Y		Y		85646
			AD-1C	Altered greyschist	Y	Y		Y		85647
			AD-1C2	Unaltered greyschist	Y	Y	Y	Y	Y	85648
A1.3	1280166	5065108	AD-1G	Medium- grained breccia with fine grained portions						85649
A2	1280171	5065125	AD-2A	Little altered lamprophyre with ankerite-filled veins and vesicle	Y	Y		Y	Y	85650
			AD2B	Highly altered lamprophyre with sparry ankerite veins		Y		Y	Y	85670
AJ1	1280169	5065106	ALT1.2	Veins in greyschist block in the diatreme.	Y	Y		Y	Y	85651
AJ2	1280171	5065125	ALT-2B	Fine grained breccia		Y				85653
			ALT2C	Highly altered lamprophyre with sparry veins and green xenolith.	Y	Y		Y	Y	85654
AJ3	1280160	5065115	ALT-3A	Medium-grained breccia						85655
			ALT-3B	Silicified breccia. From the same structure as AD1A, but c. 40 m further down the slope.						85656
T1	1271396	5049804	TP 1.3	Silicified breccia	Y	Y		Y	Y	85657

Outcrop	Easting	Northing	Sample	Sample description	SEM/MP	TE in minerals	Whole Rock chemistry	Stable isotopes	Radiogenic isotopes	OU Number
			TP4A-F	<i>Samples from across an alteration halo in mica-rich greenschist.</i>	Y	Y	Y	Y	Y	
T4	1269201	5053871	TP 4A	Hydrothermally altered greenschist						85671
			TP4B	Hydrothermally altered greenschist						85672
			TP 4C	Hydrothermally altered greenschist						85673
			TP4D	Greenschist						85674
			TP 4E	Greenschist						85675
			TP4F	Greenschist						85676
T5	1269232	5052832	TP 5.1	Sample of foliation-parallel qtz-carb veins, not in situ				Y		85659
			TP 7 a-d	<i>Samples from a fault zone related alteration halo</i>	Y	Y	Y	Y	Y	
T7	1271499	5050792	TP7A	Hydrothermally altered greenschist						85677
			TP7B	Hydrothermally altered greenschist						85678
			TP7C	Hydrothermally altered greenschist						85679
			TP7D	Greenschist						85680
RR1	1255962	5061015	RR-9	Unaltered greenschist					Y	85661
RR2	1255985	5061038	RR-10	Unaltered greenschist						85662
RR3	1255998	5061055	RR11	Unaltered greenschist						85663
RR7	1256122	5061096	RR-18	Greenschist with calcitic, poikiloblastic spots	Y	Y		Y	Y	85664
			RR19	Greenschist with ankeritic, poikiloblastic spots	Y	Y		Y	Y	85665
			RR20	sparry carbonate vein with chalcopyrite in greenschist;	X	X		X	X	85666
In Scree on N slope of ridge		Red Rock	RR-8	Silicified breccia with ankerite veins						85667
			RR-1	Kink folded greenschist with ankerite veins						85668
			SB1	From Shotover Rd by Devils Elbow. In scree- not in-situ.					Y	85669
			BD180.6	From Bullendale drilling. See MacKenzie et al. (2007) for details.				Y	Y	
			OU 64062-A	Bob's Cove Lst from Bobs Cove				Y		
			B122-A	Bob's Cove Lst from Mt Aurum area, collected by Barry				Y		