OF99-14

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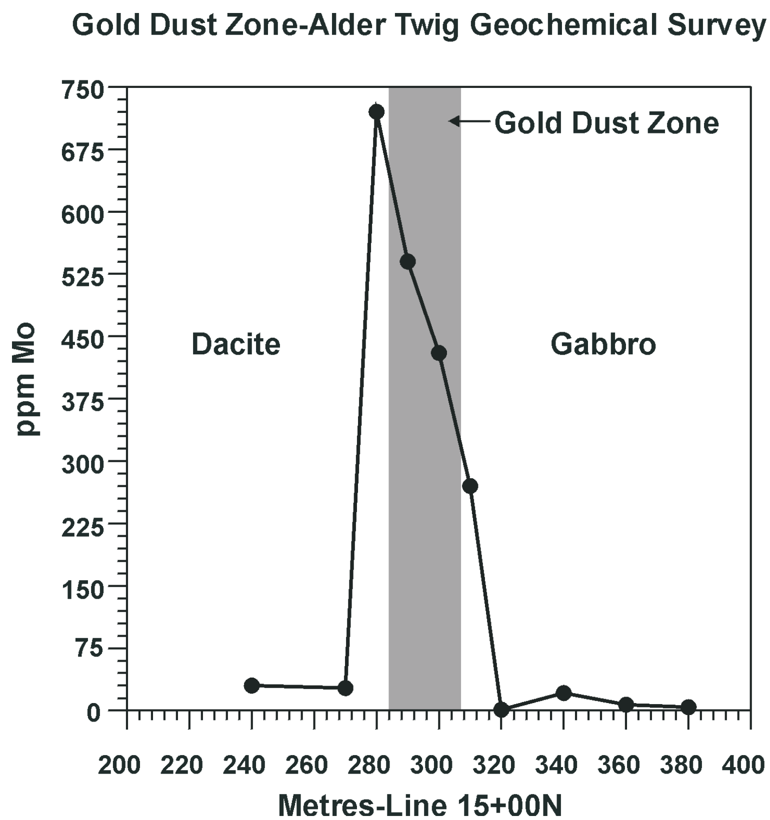

By
M.A.F. Fedikow
and D.V. Ziehlke

OPEN FILE REPORT

Manitoba
Industry, Trade
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Assessing Gold Potential In Overburden and Swamp Covered Lineaments Using the Geochemistry Of Ashed Alder (Alnus rugosa) Twigs, Gold Dust Zone, Ferro Gold Deposit Area, Snow Lake Area (NTS 63J/13)

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Winnipeg, 2000

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SUMMARY

Geochemical analysis of ashed alder (Alnus rugosa) twigs collected near the gold and molybdenum-bearing Gold Dust Zone east of Wekusko Lake indicates a Mo enrichment of up to 30 times background in the tissues. Zones of enrichment occur for approximately 50 metres along sampling transects and anomalies are demonstrated to be reproducible over a two-year time frame. The presence of carbonate-rich till in the survey area is responsible for a neutral to alkaline secondary environment thought to enhance the mobility of Mo from substrate to vegetation. This buffered environment may also suppress mobility of Au and other elements and hence their relatively low concentrations in alder twigs and consequent ineffectiveness as indicator elements. This study shows that alder twigs are particularly useful for gold exploration in overburden-covered lineaments where traditional prospecting methods are hampered by organic and inorganic surficial deposits.

INTRODUCTION

The geochemical analysis of alder (Alnus rugosa) tissues provides information useful in the search for gold mineralization (Dunn, 1995; Fedikow, 1987). Significant enrichments of Au, As, Mo and other metals have been documented in alder tissues near gold mineralization suggesting that non-essential elements are included with essential elements during nutrient acquisition. This simple observation provides explorationists with a geochemical prospecting tool that is rapid, cost-effective and easy to apply when alders are present in the area of exploration interest.

In this report we present a case history from the Gold Dust Zone (GDZ) in the Snow Lake area (Fig. 1) that demonstrates the value of alder twig-based biogeochemical prospecting. The gold zone assessed with this technique occurs in an overburden-filled lineament on the east side of Wekusko Lake in an area of historic gold exploration and production. Although gold exploration is continuing in the area, albeit at a reduced rate, masking of high potential areas by overburden and tree-covered bog continues to frustrate "traditional" methods of prospecting. The study area is characterized by limited outcrop, calcareous till and glaciolacustrine clay-dominated overburden overlain by organic deposits of variable thickness and moisture content. Vegetation consists of labrador tea (Ledum groenlandicum), alder shrubs and black spruce (Picea mariana) trees. Magnetometer and VLF-EM surveys have been undertaken since the early 1990s with limited diamond drill testing of conductors.

SAMPLE COLLECTION, PREPARATION AND ANALYSIS

Samples for this study consisted of 8 to 10 pieces of 40 cm long alder twig collected from 1 to 3 alder bushes (Alnus rugosa) at each sample site. Twigs were taken from each alder branch, stripped of leaves at the site, cut

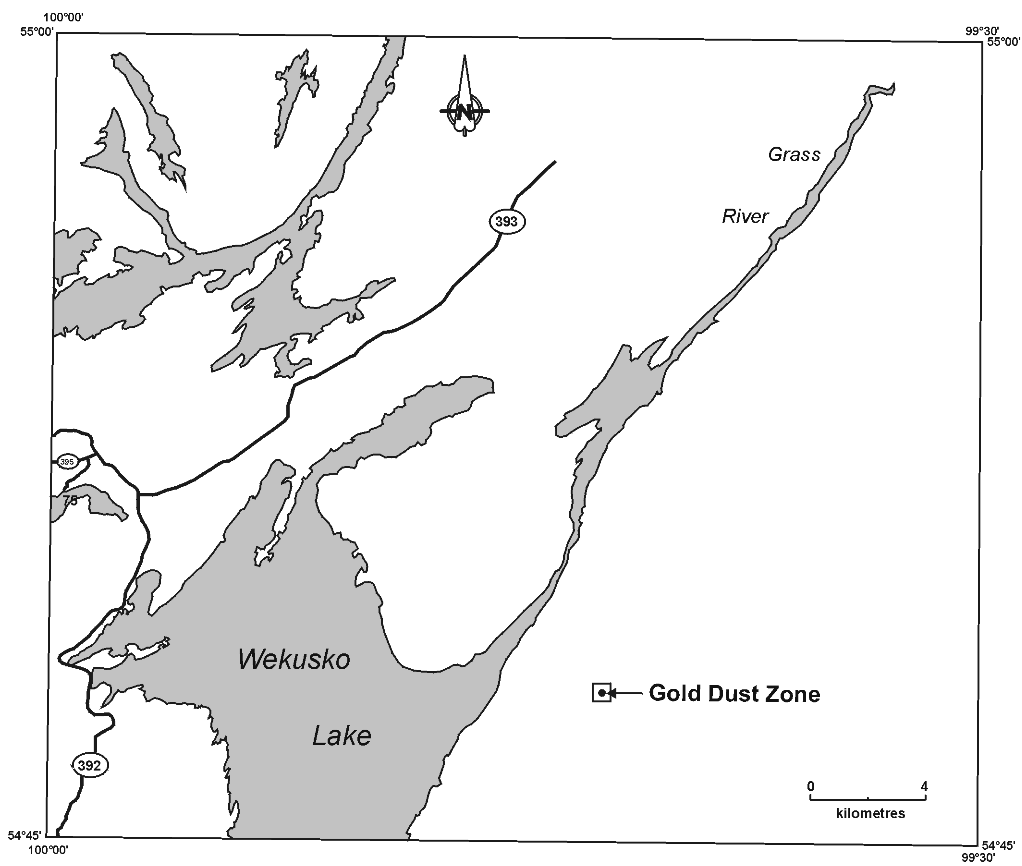


Figure 1: Location of the Gold Dust Zone (NTS 63J/13).

into 3 to 4 cm lengths and placed in numbered brown paper bags. Care was taken to standardize both length and circumference of alder twigs so that alders of similar age were assessed for metal content.

For the 1995 survey, samples were collected at 5 m intervals along grid lines 13+50N and 15+00N. The 1996 sampling was done at 10 m intervals over the mineralized zone and 20 m intervals beyond the GDZ on line 15+00N. The 1996 sampling on line 13+00N was also done at 10 m intervals throughout and near the GDZ, however, sampling spacing beyond the mineralized zone is erratic due to the lack of alders.

Twig samples of approximately 50 to 60 g each were ashed in a pottery kiln dedicated to vegetation sample preparation. Kiln temperatures were increased incrementally to a maximum of 470º C to avoid possible volatilization of gold and other metals. Approximately 0.5 g of ash were weighed into polyethylene vials for analysis by instrumental neutron activation analysis (INAA) and inductively coupled plasma-atomic emission spectrometry (ICP-AES). The samples were ashed in the laboratories of the Geological Survey of Canada (Ottawa) under the supervision of Dr. Colin Dunn.

Encapsulated ashes were shipped to Activation Laboratories Limited (Ancaster, Ontario) and analyzed for "Au + 34" by INAA. Analytical data are provided in Appendix I for INAA and Appendix II for ICP-AES analysis of 1996 samples and in Appendix III for the INAA of 1995 samples.

GEOLOGICAL SETTING OF THE GOLD DUST ZONE

The Gold Dust Zone (GDZ) is located east of the Ferro gold deposit (Fig. 2). It occurs within the Gold Dust Shear Zone (GDSZ) at or near the contact between Missi Group andesite and basalt on the east and feldspar porphyritic gabbro to the west (Fig. 3). Dacitic to rhyolitic ash and lapilli tuff units also occur in the general area of the deposit. Mineralization at the GDZ comprises disseminated native Au, arsenopyrite (0.5–5%), up to 2% sphalerite, trace to 1% pyrite, pyrrhotite and chalcopyrite, rare galena and trace to 0.5% molybdenite within a quartz-feldspar porphyry dyke situated within the GDSZ. The dyke is also crosscut by white quartz veins as well as veinlets and masses of tourmaline. Diamond drilling has intersected localized zones of up to "15.6 ft. of 0.206 oz./ton Au and 14.8 ft. of 0.748 oz./ton Au". The deposit is situated in a low-lying linear depression and was discovered by Strider Resources Ltd. in 1989 during diamond drilling of an oxidized arsenopyrite occurrence and a coincident VLF-EM conductor.

GOLD DUST ZONE SURVEY

The alder twig geochemical survey conducted at the GDZ comprises sampling from two grid lines for both 1995 and 1996. The 1995 samples were collected at 5 m intervals by D. V. Zielhke (Strider Resources Ltd.) along lines 15+00N (8 samples) and 13+50N (6 samples). The 1996 samples were collected by M.A.F. Fedikow (Manitoba Geological Survey) at 10 m intervals along line 15+00N (10 samples) and 13+50N (8 samples). Sample locations between 1995 and 1996 do not correspond exactly.

The geological setting of mineralized zones and the location of lines 15+00N and 13+50N are depicted in Figure 3. Analytical data from the survey is summarized in Appendices I, II and III. Analytical results for Au, As and Mo are reproduced on Figures 4 and 5 for the 1995 survey and on Figures 6 and 7 for 1996 results. Figures 8 and 9 graphically depict the responses for Au and Mo near the GDZ. The elements Ag, Hf, Hg, Ir, Se, Sn, Ta, W and the rare earth elements were consistently below the lower limits of determination.

1995 results

Molybdenum concentrations in ashed alder twig samples are exceptionally enriched directly over the mineralized quartz-feldspar porphyry host rocks of the GDZ (Figs. 4 and 5). The Mo contents along line 15+00N range from 280 to 600 ppm at the deposit and decrease to 15 ppm in a single sample collected 7 m to the west. Arsenic varies sympathetically with Mo albeit with much lower contrast, varying from 5.2 to 7.5 ppm at the deposit to 2.0 ppm 7 m east. Rubidium is moderately enriched over the mineralized zone (130–150 ppm) compared to 64 ppm at background (Appendix III). Results from line 13+50N mimic those of line 15+00N although absolute metal contents are lower. Molybdenum varies from 44 to

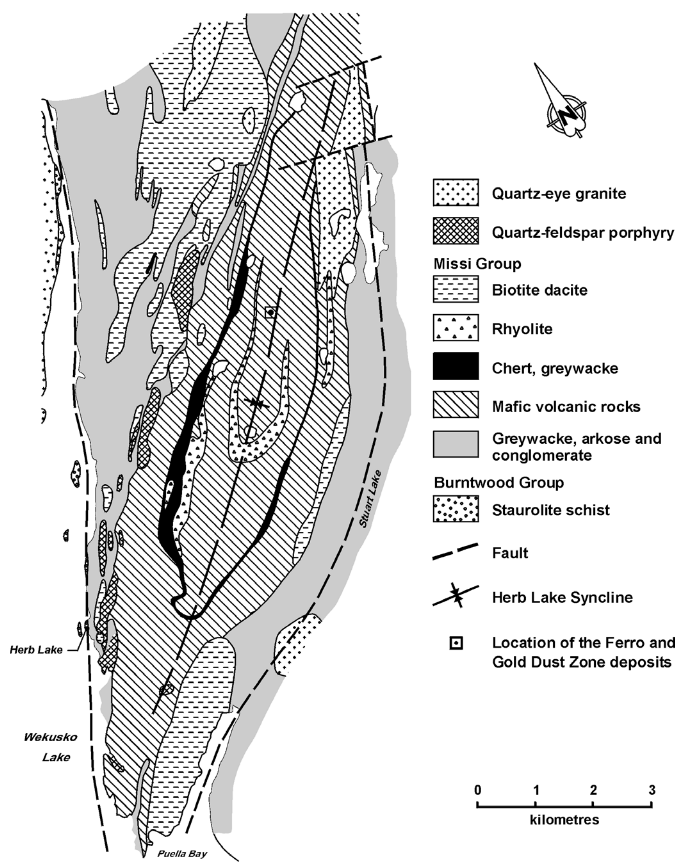


Figure 2: Geological setting of the Gold Dust Zone and the Ferro gold deposit. Geology modified after Fedikow et al. (1993).

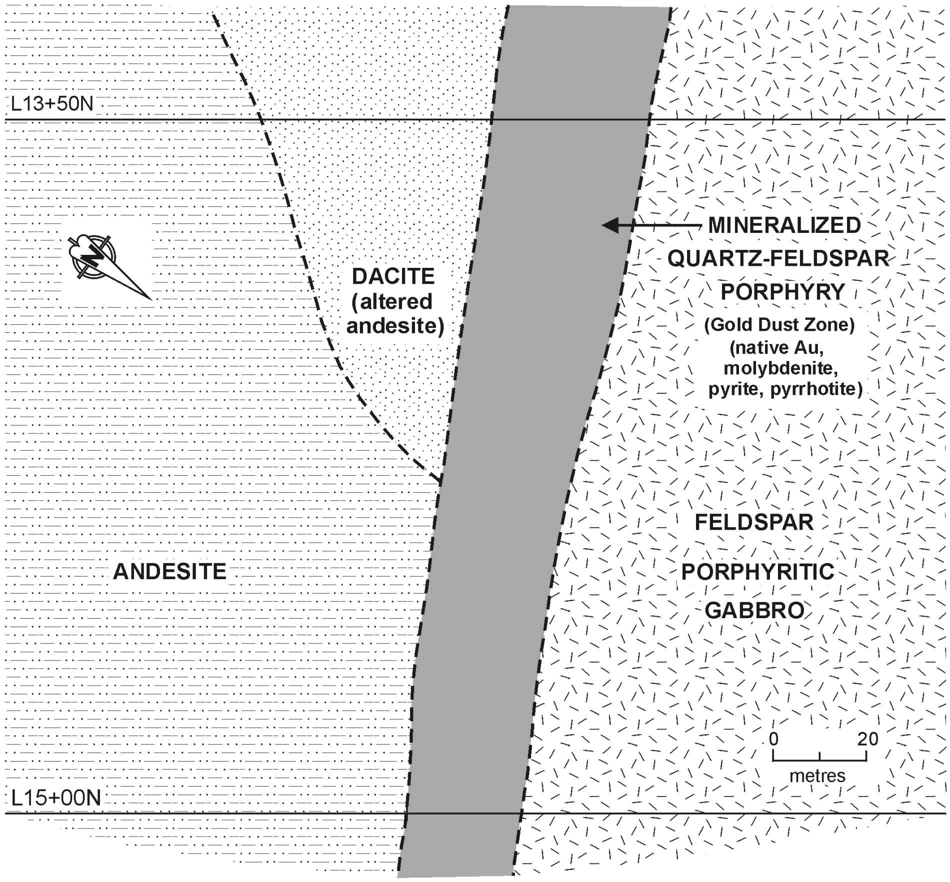
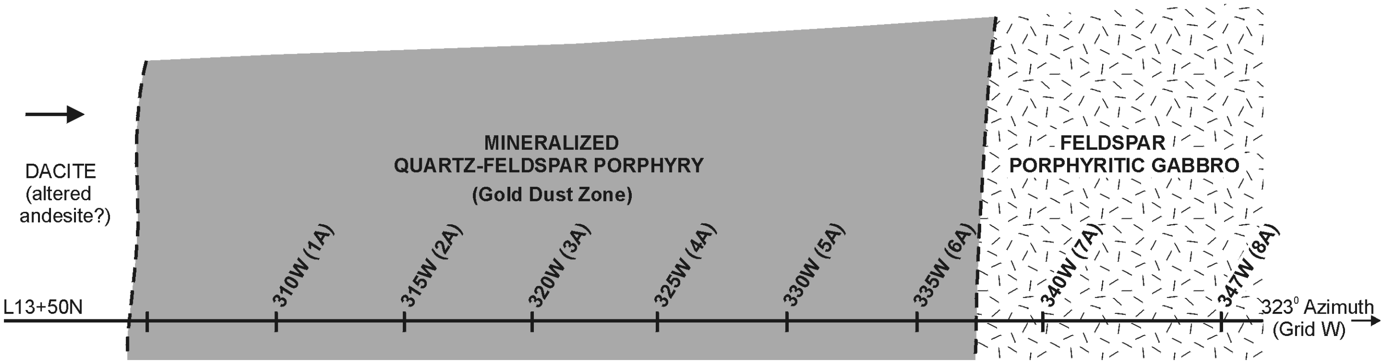


Figure 3: Detailed geological setting of the Gold Dust Zone and location of sampling transects 13+50N and 15+00N.



Au ppb	33	16	22	11	31	14	25	28
Mo ppm	220	240	250	98	110	44	16	35
As ppm	5.3	6.8	6.9	5.4	8.7	5.8	7.5	5.8

0 5
metres

Figure 4: Sample locations and analytical results for Au, Mo and As along line 13+50N, 1995 Alnus rugosa twig samples.

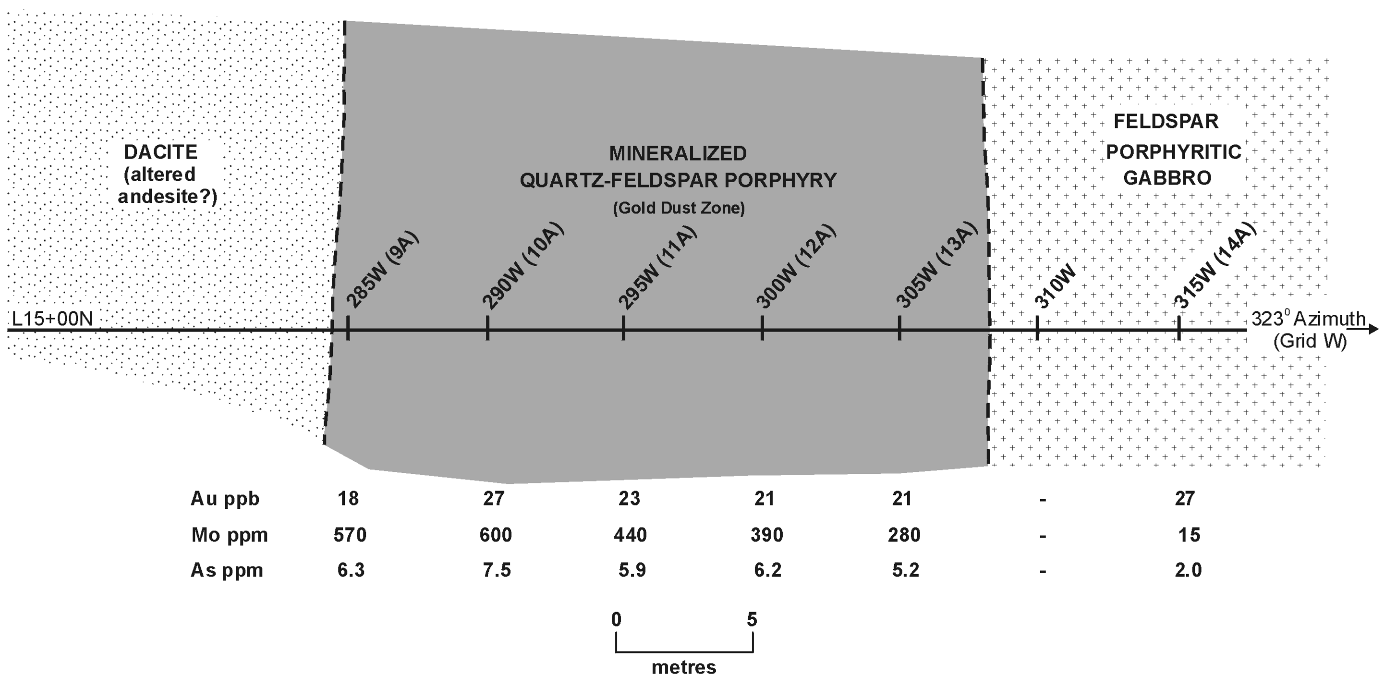


Figure 5: Sample locations and analytical results for Au, Mo and As along line 15+00N, 1995 Alnus rugosa twig samples.

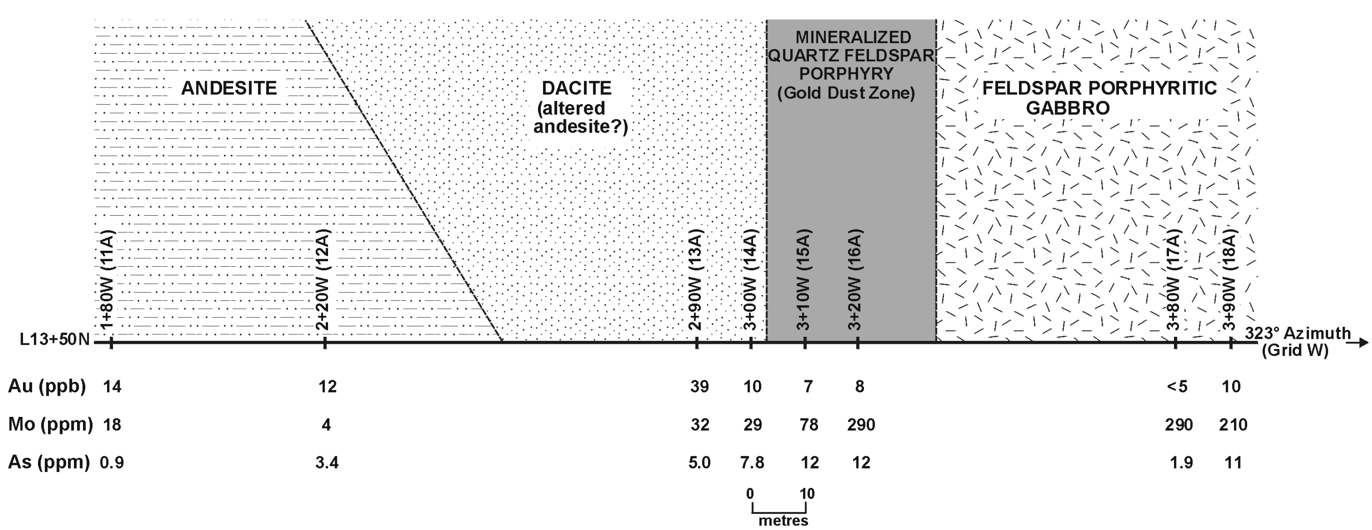
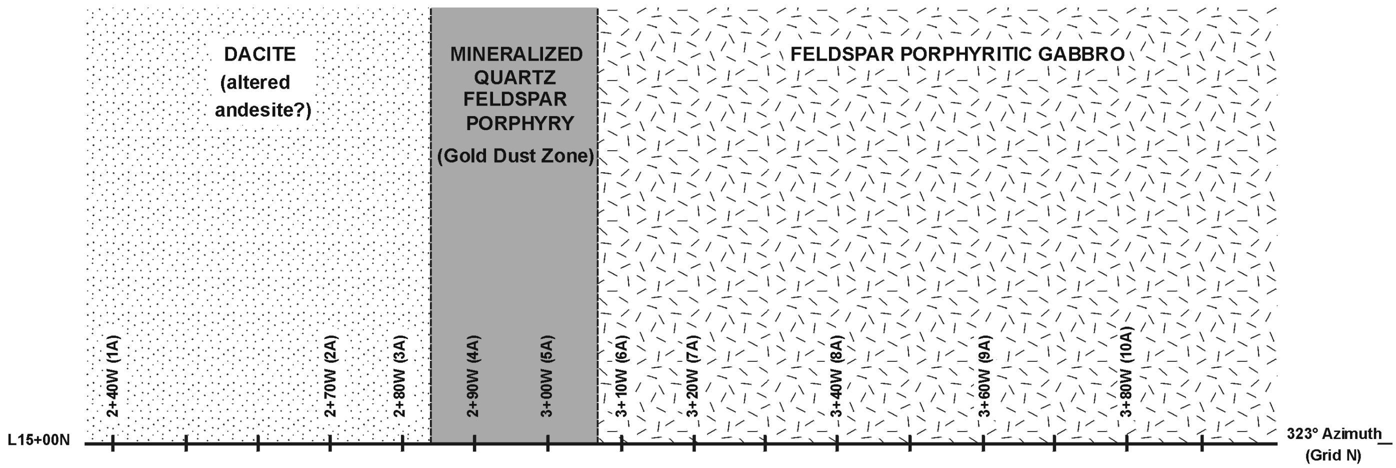


Figure 6: Sample locations and analytical results for Au, Mo and As along line 13+50N, 1996 Alnus rugosa twig samples.



	2+40W (1A)	2+70W (2A)	2+80W (3A)	2+90W (4A)	3+00W (5A)	3+10W (6A)	3+20W (7A)	3+40W (8A)	3+60W (9A)	3+80W (10A)
Au (ppb)	9	13	6	8	37	13	13	7	11	8
Mo (ppm)	30	27	720	540	430	270	22	21	7	4
As (ppm)	14	10	8	7.9	5.6	7.0	3.0	1.5	1.4	1.4

0 10
metres

Figure 7: Sample locations and analytical results for Au, Mo and As along line 15+00N, 1996 Alnus rugosa twig samples.

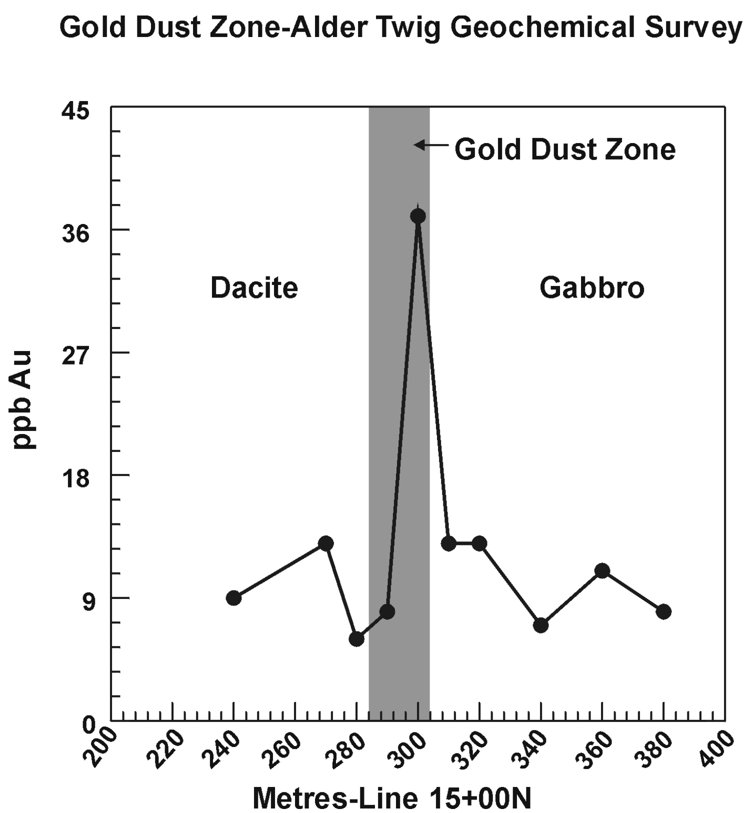


Figure 8: Variation in concentration of Au in ashed alder (Alnus rugosa) twigs along line 15+00N near the Gold Dust Zone.

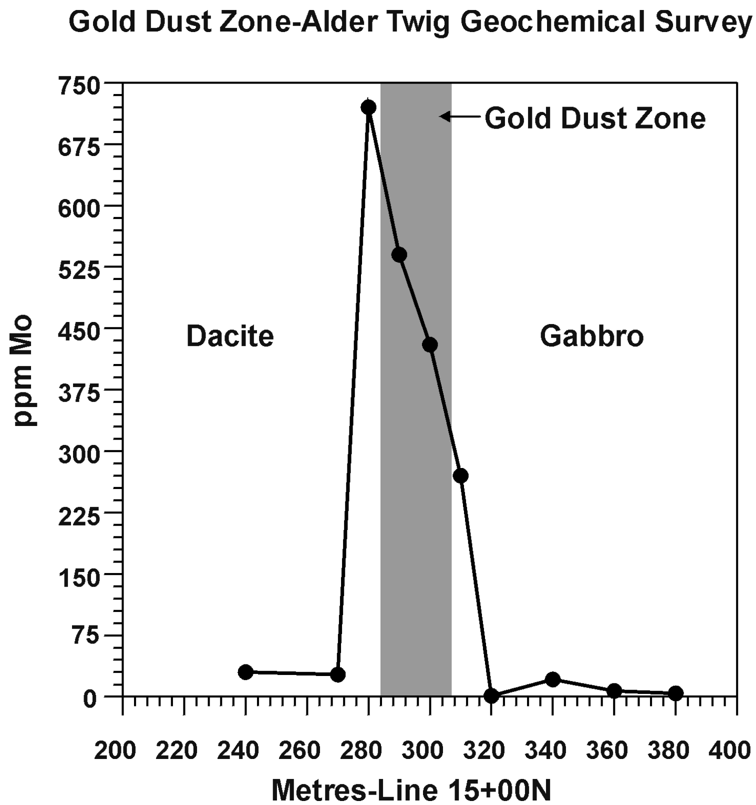


Figure 9: Variation in concentration of Mo in ashed alder (Alnus rugosa) twigs along line 15+00N near the Gold Dust Zone.

250 ppm over the deposit with values of 16 ppm and 35 ppm 3 to 10 m east of the mineralized quartz feldspar porphyry. There is no discernible difference in Au and As contents in ashed alder samples between mineralized and "background" sample locations. A moderate Cs enrichment (2.7 and 1.4 ppm) occurs over the mineralized zone as compared to 0.7 and 0.6 ppm at background. A similar response is noted for U with analysis of 0.4, 0.6, 0.7 and 0.9 ppm over the zone and <0.1 ppm outside of the deposit.

1996 results

The high contrast Mo concentrations of up to 30 times background in samples collected over the mineralized zone on line 15+00N prompted a return to the survey site in 1996. Both lines 15+00N and 13+50N were resampled, albeit at slightly different sample stations.

The exceptional contrast between Mo concentrations in ashed alder samples collected over the GDZ and non-mineralized feldspar-porphyritic gabbro identified in 1995 is reproduced in the 1996 results from both sampling transects (Figs. 6 and 7; Appendix I and II). The range in Mo concentrations over the GDZ from line 15+00N (430 and 540 ppm, 2 samples) is comparable to that for the 1995 results (280–600 ppm, 5 samples). The 1996 data from this line also show very high Mo contents just outside of the mapped limits of the mineralization (270 and 720 ppm) suggesting either mineralization may be more extensive than currently known or hydromorphic and/or glacial dispersion of Mo has occurred. Arsenic contents range from 3.0 to 10.0 ppm within 14 m of the GDZ and from 1.4 to 1.5 ppm (3 samples) up to 60 m west of the GDZ. This pattern is inconsistent to the east of the mineralization where a 14.0 ppm As analysis was obtained in an area of no known mineralization. An increase in the As contents of ashed alder samples collected over the GDZ (5.2–7.5 ppm) as compared to a single sample collected 7 m to the west (2.0 ppm) was documented in the 1995 results. Other trends in the data from line 15+00N include depletions over the deposit relative to "background" for Ba (260–510 ppm versus 2100–5000 ppm), Cs (<0.5–1.3 ppm versus 3–10 ppm), Co (3–5 ppm versus 21–78 ppm), Sr (480–570 ppm versus 430–1500 ppm), Fe (0.13–0.15% versus 0.17–0.26%) and Ni (<50 ppm versus <50–120 ppm).

The 1996 results from line 13+50N also reproduce the 1995 Mo enrichments in samples over the GDZ. Molybdenum varies from 78 to 290 ppm over the GDZ and from 4 to 32 ppm outside of the mineralization. Two high Mo analyses of 290 and 210 ppm were identified 60 m and 70 m west, respectively, of the GDZ in apparently non-mineralized (?) feldspar-porphyritic gabbro. Arsenic contents in the two samples from this location are comparable to the range of 5.0 to 12 ppm As over the GDZ and higher than the results (0.9, 3.4 ppm) 80 m east of the GDZ. Lower Sr (<300 ppm) was observed in ashed alder twigs over the mineralized zone as compared to samples collected at "background (<300–1100 ppm). A single duplicate sample pair collected in 1996 indicates good analytical reproducibility for Mo (28, 30 ppm) and As (8.4, 7.2 ppm) and acceptable reproducibility for Au (10, <5 ppb).

DISCUSSION

Molybdenum concentrations in ashed samples of alder twigs that range from 44 to 250 ppm (line 13+50N) and 280 to 600 ppm (line 15+00N) in the 1995 alder twig survey and from 78 to 290 ppm and 270 to 720 ppm from 1996 sampling along the same transects, respectively, indicate extraordinary Mo enrichment in the plant tissues. This is noteworthy since the average Mo content in plant ash is 13 ppm (Brooks, 1972). The localization of these responses over the quartz feldspar porphyry host rocks to the GDZ is significant because molybdenite (10–2627 ppm Mo) occurs in association with the gold mineralization. The rapid decrease in Mo contents in the alder twigs outside of the mineralized zone indicates a relationship exists between Mo concentrations in alder twigs, overburden and the GDZ. This has implications for gold mineral exploration where a Mo association can be demonstrated or is suspected on the basis of historical data (e.g. mining records and/or previous exploration).

Because the alders derive their essential and non-essential nutrients from the substrate in which they are rooted, it is strongly suspected that the overburden also contains high Mo contents that are transferred to the alder during growth. Molybdenum is an essential micronutrient in plants and is often combined with large molecules such as proteins and enzymes for catalysis. It is acquired from the substrate as molybdate ions and exhibits high geochemical mobility in neutral or alkaline environments. The carbonate-bearing till that characterizes the area of the GDZ biogeochemical survey (McMartin, 1994) has effectively beneficiated the mobility of Mo and its subsequent uptake by the alders during nutrient acquisition. This same alkaline environment may have inhibited the mobility of other metals such as Au and As and hence the relatively low responses for these elements in alder tissues.

The geological setting of the GDZ is typical of many of the gold deposits discovered on the east side of Wekusko Lake. Typically, the gold zones occur in quartz veins or in association with quartz and/or feldspar phyric felsic dykes that occupy faults and shear zones. These zones of weakness occur in or under linear swamps where drainage is poor and there is very little outcrop. This environment is difficult to explore particularly if the first phase of exploration is prospecting.

Alders generally grow profusely in swamp or low-lying environments and as such offer a potentially valuable sampling medium for screening lineaments and focussing on specific lineaments or portions thereof. Although this brief alder geochemical survey utilized a small number of samples to demonstrate elevated Mo contents, it has indicated the potential to explore for gold mineralization with a Mo association in environments where outcrop exposure and drainage is poor. Gold and As contents of the alders were less informative, however, a more extensive survey might elucidate their usefulness.

RECOMMENDATIONS

The documentation of extraordinary Mo enrichment in ashed alder twig samples collected over the GDZ should be utilized as follows:

1. Expand the survey to cover the immediate area of the deposit and the structure/lineament containing the mineralization.

2. Sampling and analytical protocols established in the GDZ orientation study should be maintained.

3. Sample spacing should reflect the size of the deposit/target being sought with collection initiated at 25 m spacing.

4. Sample spacing can be increased once the areal extent of Mo dispersion at the GDZ has been established.

5. Sampling should be conducted in as short a time-frame as possible to avoid possible seasonal variations of Mo contents in alders.

6. Drainage characteristics of the survey area should be documented so that possible Mo dispersion from mineralized zones can be detected.

CONCLUSIONS

This brief alder twig geochemical survey centered on the GDZ indicates the following:

1. Alder (Alnus rugosa) twigs growing over the GDZ are highly anomalous in Mo reaching concentrations of 720 ppm in ashed sample. Molybdenum is enriched up to 30 times background in these samples.

2. This enrichment is localized directly over and immediately adjacent to native gold-molybdenite-iron sulphide mineralization in the GDZ.

3. Depth to bedrock is indeterminate, however, organic/inorganic surficial deposits are likely to be in the order of 1 to 5 m thick.

4. Molybdenum enrichment in alder tissues is consistent over a two-year time frame as demonstrated by the 1995 and 1996 surveys.

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Appendix I: Instrumental Neutron Activation Analyses (INAA) of Ashed Alder (Alnus rugosa) Twig Samples, 1996.

Element	Grid Reference	Au	Ag	As	Ba	Br	Ca	Co	Cr	Cs	Fe	Hf	Hg	Ir	K	Mo	Na	Ni
Units		PPB	PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	%	PPM	PPM	PPB	%	PPM	PPM	PPM
Detection Limit		5	2	0.5	10	1	0.2	1	1	0.5	0.05	0.5	1	2	0.05	2	10	50
Sample																		
AL96-1483	L15+00N/2+40W	9	-2	14	2600	12	28.6	78	6	8.1	0.24	-0.5	-1	-2	18.7	30	474	-50
AL96-1484	L15+00N/2+70W	13	-2	10	3900	12	29.2	54	13	7.6	0.19	0.7	-1	-2	17.9	27	261	120
AL96-1485	L15+00N/2+80W	6	-2	8	260	8	31.7	4	7	-0.5	0.13	-0.5	-1	-2	15.5	720	556	-50
AL96-1486	L15+00N/2+90W	8	-2	7.9	380	10	32.1	5	13	1.3	0.14	-0.5	-1	-2	15.9	540	247	-50
AL96-1487	L15+00N/3+00W	37	-2	5.6	290	10	39	3	10	0.9	0.14	-0.5	-1	-2	15.2	430	262	-50
AL96-1488	L15+00N/3+10W	13	-2	7	510	9	35.4	4	10	0.9	0.15	-0.5	-1	-2	13.7	270	280	-50
AL96-1489	L15+00N/3+20W	13	-2	3	2700	15	28.8	31	15	5.1	0.17	-0.5	-1	-2	16.4	-2	446	-50
AL96-1490	L15+00N/3+40W	7	-2	1.5	2100	13	27	28	12	3	0.17	-0.5	-1	-2	22.5	21	223	95
AL96-1491	L15+00N/3+60W	11	-2	1.4	3400	17	33.8	21	12	5.4	0.15	-0.5	-1	-2	13.9	7	292	-50
AL96-1492	L15+00N/3+80W	8	-2	1.4	5000	19	25.6	38	5	10	0.26	-0.5	-1	-2	18.2	4	424	-50
AL96-1493	L13+50N/1+80W	14	-2	0.9	4900	12	32.5	34	14	4.7	0.22	-0.5	-1	-2	14.2	18	268	-50
AL96-1494	L13+50N/2+20W	12	-2	3.4	4100	12	28.7	24	6	12	0.14	-0.5	-1	-2	17.6	4	355	-50
AL96-1495	L13+50N/2+90W	39	-2	5	420	7	35.3	3	7	0.9	0.12	-0.5	-1	-2	15.1	32	620	-50
AL96-1496	L13+50N/3+00W	10	-2	7.2	300	6	34.8	2	6	1.1	0.11	-0.5	-1	-2	13.4	28	516	-50
AL96-1499	L13+50N/3+10W	7	-2	12	240	8	36.4	2	4	0.7	0.13	-0.5	-1	-2	13.3	78	570	-50
AL96-1500	L13+50N/3+20W	8	-2	12	530	11	35.2	3	4	1.7	0.13	-0.5	-1	-2	13.7	290	1120	-50
AL96-1501	L13+50N/3+80W	-5	-2	9.1	1700	22	32.6	48	8	0.8	0.16	-0.5	-1	-2	15.2	290	448	-50
AL96-1502	L13+50N/3+90W	10	-2	11	250	9	37.9	2	11	1	0.12	-0.5	-1	-2	12.2	210	321	-50

Element	Grid Reference	Rb	Sb	Sc	Se	Sn	Sr	Ta	Th	U	W	Zn	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Ash
Units		PPM	PPM	PPM	PPM	%	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%
Detection Limit		5	0.1	0.1	2	0.005	300	0.5	0.1	0.1	1	20	0.1	3	5	0.1	0.01	0.5	0.05	0.05	
Sample																					
AL96-1483	L15+00N/2+40W	690	0.3	0.4	-2	-0.008	1100	-0.5	-0.1	-0.1	-1	4200	5.3	5	-5	0.3	-0.02	-0.5	-0.05	-0.05	1.52
AL96-1484	L15+00N/2+70W	700	0.2	0.2	-2	-0.008	1500	-0.5	-0.1	-0.1	-1	2100	23	26	-5	0.9	-0.03	-0.5	0.15	-0.05	1.77
AL96-1485	L15+00N/2+80W	170	0.2	0.2	-2	-0.005	520	-0.5	-0.1	-0.1	-1	860	1.6	-3	-5	0.1	-0.02	-0.5	-0.05	-0.05	1.96
AL96-1486	L15+00N/2+90W	220	-0.1	0.2	-2	-0.006	480	-0.5	-0.1	-0.1	-1	1800	0.6	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	1.91
AL96-1487	L15+00N/3+00W	210	-0.1	0.2	-2	-0.006	540	-0.5	-0.1	-0.1	-1	1600	0.6	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.33
AL96-1488	L15+00N/3+10W	210	0.2	0.1	-2	-0.006	570	-0.5	0.2	-0.1	-1	2100	0.9	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.24
AL96-1489	L15+00N/3+20W	580	0.3	0.3	-2	-0.009	1400	-0.5	0.3	-0.1	-1	2100	54	54	17	2.1	0.41	-0.5	-0.05	-0.05	1.62
AL96-1490	L15+00N/3+40W	490	0.2	0.1	-2	-0.007	820	-0.5	0.3	-0.1	-1	6000	3.2	-3	-5	0.1	-0.02	-0.5	-0.05	-0.05	1.99
AL96-1491	L15+00N/3+60W	520	0.2	0.2	-2	-0.007	430	-0.5	-0.1	-0.1	-1	1600	11	11	6	0.4	-0.02	-0.5	0.18	-0.05	2.39
AL96-1492	L15+00N/3+80W	600	0.3	0.3	-2	-0.007	1100	-0.5	-0.1	-0.1	-1	2900	13	11	-5	0.6	0.19	-0.5	-0.05	-0.05	1.56
AL96-1493	L13+50N/1+80W	600	0.2	0.2	-2	-0.007	1100	-0.5	0.5	-0.1	-1	1600	9.2	8	-5	0.4	-0.03	-0.5	-0.05	-0.05	1.87
AL96-1494	L13+50N/2+20W	750	0.3	0.1	-2	-0.007	990	-0.5	-0.1	-0.1	-1	2900	8.4	9	-5	0.3	-0.03	-0.5	-0.05	-0.05	1.9
AL96-1495	L13+50N/2+90W	190	0.2	0.2	-2	-0.005	520	-0.5	-0.1	-0.1	-1	1800	0.6	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.5
AL96-1496	L13+50N/3+00W	160	-0.1	0.1	-2	-0.005	640	-0.5	-0.1	-0.1	-1	2500	0.6	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.37
AL96-1499	L13+50N/3+10W	110	-0.1	0.2	-2	-0.006	-300	-0.5	0.2	-0.1	-1	3200	0.7	-3	-5	0.1	-0.02	-0.5	-0.05	-0.05	2.16
AL96-1500	L13+50N/3+20W	110	0.1	0.3	3	-0.006	-300	-0.5	-0.1	-0.1	-1	2800	0.6	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.37
AL96-1501	L13+50N/3+80W	320	-0.1	0.1	-2	-0.007	580	-0.5	-0.1	-0.1	-1	3000	5.6	6	-5	0.3	-0.02	-0.5	-0.05	-0.05	1.83
AL96-1502	L13+50N/3+90W	93	0.1	0.2	-2	-0.005	-300	-0.5	-0.1	-0.1	-1	2500	0.5	-3	-5	-0.1	-0.02	-0.5	-0.05	-0.05	2.69

Appendix II: Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) Analyses of Ashed Alder (Alnus rugosa) Twig Samples, 1996.

SAMPLE	Grid Reference	Ag	Cd	Cu	Mn	Mo	Ni	Pb	Zn	Al	As	Ba	Be	Bi	Co	Cr	Fe	Mg	Na	P	Sb	Sc	Sn
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	ppm	ppm	ppm	ppm
	Detection Limit	**0.4**	**0.5**	**1**	**2**	**4**	**1**	**2**	**1**	**0.01**	**20**	**1**	**2**	**20**	**1**	**2**	**0.01**	**0.01**	**0.01**	**5**	**10**	**2**	**20**
ICP96-1483	**L15+00N/2+40W**	-0.4	3.8	294	6990	30	44	14	3600	0.16	-20	722	-2	-20	74	4	0.20	4.46	0.04	34900	-10	-2	-20
ICP96-1484	**L15+00N/2+70W**	-0.4	2.2	326	5470	26	100	14	1840	0.10	-20	736	-2	-20	50	10	0.16	3.98	-0.02	37400	-10	-2	-20
ICP96-1485	**L15+00N/2+80W**	-0.4	0.8	190	2220	714	16	10	740	0.04	-20	446	-2	-20	4	-2	0.12	2.28	0.04	24400	-10	-2	-20
ICP96-1486	**L15+00N/2+90W**	-0.4	1.6	270	4450	490	8	4	1410	0.02	-20	624	-2	-20	6	10	0.12	2.76	0.02	32000	-10	-2	-20
ICP96-1487	**L15+00N/3+00W**	-0.4	1.2	258	4350	398	4	8	1230	0.02	-20	580	-2	-20	4	6	0.10	2.28	0.02	23700	-10	-2	-20
ICP96-1488	**L15+00N/3+10W**	0.6	1.4	316	4370	266	12	8	1650	0.02	-20	768	-2	-20	6	10	0.14	2.40	0.02	30900	-10	-2	-20
ICP96-1489	**L15+00N/3+20W**	-0.4	2.2	296	1990	-4	42	22	1770	0.20	-20	570	-2	-20	28	14	0.18	4.52	0.08	37400	-10	-2	-20
ICP96-1490	**L15+00N/3+40W**	0.4	4.2	290	19000	22	68	14	5130	0.06	-20	740	-2	-20	28	10	0.18	2.54	-0.02	26900	-10	-2	-20
ICP96-1491	**L15+00N/3+60W**	-0.4	1.2	204	7220	8	30	8	1250	0.06	-20	788	-2	-20	20	8	0.14	2.64	-0.02	29300	-10	-2	-20
ICP96-1492	**L15+00N/3+80W**	-0.4	2.8	250	9560	-4	40	20	2450	0.16	-20	400	-2	-20	36	2	0.24	4.32	0.04	38600	-10	-2	-20
ICP96-1493	**L13+50N/1+80W**	-0.4	1.8	292	8310	16	22	6	1210	0.10	-20	706	-2	-20	30	12	0.18	3.98	0.02	39700	-10	-2	-20
ICP96-1494	**L13+50N/2+20W**	-0.4	2.6	220	18800	-4	58	14	2340	0.04	-20	1060	-2	-20	22	2	0.14	3.26	0.04	36900	-10	-2	-20
ICP96-1495	**L13+50N/2+90W**	-0.4	1.4	284	5300	28	10	6	1390	0.04	-20	758	-2	-20	4	2	0.10	2.38	0.06	26000	-10	-2	-20
ICP96-1496	**L13+50N/3+00W**	-0.4	1.0	246	7220	28	10	10	2070	0.02	-20	506	-2	-20	2	2	0.10	2.42	0.04	24200	-10	-2	-20
ICP96-1499	**L13+50N/3+10W**	-0.4	-0.5	226	5820	70	6	8	2440	0.04	-20	418	-2	-20	2	-2	0.12	2.42	0.04	21500	-10	-2	-20
ICP96-1500	**L13+50N/3+20W**	-0.4	-0.5	296	10500	286	4	6	2320	0.04	-20	752	-2	-20	4	2	0.10	2.52	0.04	27100	-10	-2	-20
ICP96-1501	**L13+50N/3+80W**	0.4	1.6	252	5210	306	32	12	2540	0.12	-20	1280	-2	-20	44	-2	0.16	3.16	0.04	36600	-10	-2	-20
ICP96-1502	**L13+50N/3+90W**	0.4	1.4	236	4830	202	4	4	1990	0.02	-20	448	-2	-20	2	8	0.10	1.16	0.02	18900	-10	-2	-20

SAMPLE	Grid Reference	Sr	Ti	V	W	Y	Zr
		ppm	%	ppm	ppm	ppm	ppm
	Detection Limit						
ICP96-1483	**L15+00N/2+40W**	806	-0.02	-2	80	-2	-2
ICP96-1484	**L15+00N/2+70W**	936	-0.02	-2	40	4	-2
ICP96-1485	**L15+00N/2+80W**	404	-0.02	-2	-20	-2	-2
ICP96-1486	**L15+00N/2+90W**	390	-0.02	-2	-20	-2	-2
ICP96-1487	**L15+00N/3+00W**	406	-0.02	-2	-20	-2	-2
ICP96-1488	**L15+00N/3+10W**	410	-0.02	-2	-20	-2	-2
ICP96-1489	**L15+00N/3+20W**	1050	-0.02	-2	20	6	-2
ICP96-1490	**L15+00N/3+40W**	456	-0.02	-2	120	-2	-2
ICP96-1491	**L15+00N/3+60W**	546	-0.02	-2	-20	2	-2
ICP96-1492	**L15+00N/3+80W**	740	-0.02	-2	40	4	-2
ICP96-1493	**L13+50N/1+80W**	706	-0.02	-2	20	-2	-2
ICP96-1494	**L13+50N/2+20W**	672	-0.02	-2	40	-2	-2
ICP96-1495	**L13+50N/2+90W**	368	-0.02	-2	-20	-2	-2
ICP96-1496	**L13+50N/3+00W**	372	-0.02	-2	40	-2	-2
ICP96-1499	**L13+50N/3+10W**	362	-0.02	-2	40	-2	-2
ICP96-1500	**L13+50N/3+20W**	362	-0.02	-2	40	-2	-2
ICP96-1501	**L13+50N/3+80W**	392	-0.02	-2	40	-2	-2
ICP96-1502	**L13+50N/3+90W**	276	-0.02	-2	40	-2	-2

Appendix III: Instrumental Neutron Activation Analysis (INAA) of Ashed Alder (Alnus rugosa) Twig Samples, 1995.

Sample	Element	Au	As	Ba	Br	Ca	Co	Cr	Cs	Fe	K	Mo	Na	Rb	Sb	Sc	Sr	Th	U	Zn
	Detection Limit	**ppb**	**ppm**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**%**	**%**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
	Grid Reference	**5**	**0.5**	**10**	**1**	**0.2**	**1**	**1**	**0.5**	**0.05**	**0.05**	**2**	**10**	**50**	**5**	**0.1**	**300**	**0.1**	**0.1**	**20**
1A	**13+50N,310W**	33	5.3	500	12	26.1	3	4	0.8	0.15	19.1	220	1030	230	0.3	0.2	510	0.1	<0.1	1400
2A	**13+50N,315W**	16	6.8	820	8	23.4	7	3	1.4	0.13	20	240	790	230	0.5	0.3	720	<0.1	0.4	1800
3A	**13+50N,320W**	22	6.9	460	5	23.8	2	6	2.7	0.12	16.4	250	1300	180	0.6	0.2	500	<0.1	0.7	2200
4A	**13+50N,325W**	11	5.4	480	6	24.5	3	4	0.6	0.14	15	98	664	110	0.5	0.3	530	0.2	0.6	2900
5A	**13+50N,330W**	31	8.7	250	7	25.9	2	4	0.8	0.14	17.7	110	1020	140	1	0.4	520	<0.1	<0.1	2300
6A	**13+50N,335W**	14	5.8	260	4	25.3	2	4	<0.5	0.12	15.6	44	637	150	0.5	0.2	620	0.1	0.9	2200
7A	**13+50N,340W**	25	7.5	320	12	28.9	3	4	0.7	0.15	12.5	16	837	150	0.5	0.3	640	0.4	<0.1	2800
8A	**13+50N,347W**	28	5.8	580	5	23.8	3	7	0.6	0.17	18.7	35	1170	220	0.9	0.3	620	0.4	<0.1	1400
9A	**15+00N,285W**	18	6.3	340	5	29.3	4	2	0.7	0.12	14.6	570	670	130	0.4	0.2	750	<0.1	<0.1	1400
10A	**15+00N,290W**	27	7.5	480	6	27.4	8	5	0.8	0.13	14.5	600	855	150	1.1	0.3	640	0.2	1.2	1200
11A	**15+00N,295W**	23	5.9	420	12	31.1	3	<1	<0.5	0.15	12.7	440	644	140	0.3	0.3	940	<0.1	<0.1	1400
12A	**15+00N,300W**	21	6.2	450	10	30.8	3	3	0.5	0.14	12.2	390	594	140	0.1	0.2	690	<0.1	<0.1	910
13A	**15+00N,305W**	21	5.2	510	11	28.2	4	3	<0.5	0.16	14.2	280	664	140	0.2	0.2	630	<0.1	<0.1	1100
14A	**15+00N,315W**	27	2	870	14	29.1	13	3	<0.5	0.14	10.9	15	688	64	0.3	0.3	570	<0.1	<0.1	1200