SEASONAL VARIATION OF GOLD CONTENT OF STREAM SEDIMENTS HARRIS CREEK, NEAR VERNON* (82L/02)

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INTRODUCTION

Concentrations of gold in stream sediments can reflect both the presence of gold mineralisation in a stream basin or, like other heavy minerals (Fletcher *et al.*, in press; Saxby and Fletcher, 1986 and in press), the influence of local hydraulic conditions on its differential transport and segregation from the less dense components of the sediment. In extreme cases, these processes lead to the formation of placer deposits. However, they are more often encountered by the exploration geologist as a major source of variability and difficulty in repeating results of geochemical or heavy mineral surveys for gold. Here we present results of the first phase of an ongoing study of seasonal variations in gold content of a single anomalous stream. Because high density minerals, such as magnetite, tend to accumulate with gold during sediment transport and are less susceptible to the analytical errors associated with very rare particles of gold, it is also helpful to consider data for the magnetic mineral fraction.

LOCATION

Harris Creek rises in the Okanagan Highlands east of Vernon and flows north through Lumby (Figure 6-4-1). It was selected for this study because it has exceptionally high gold concentrations in the present day stream bed and is easily accessible, allowing trouble-free removal of bulk sediment samples.

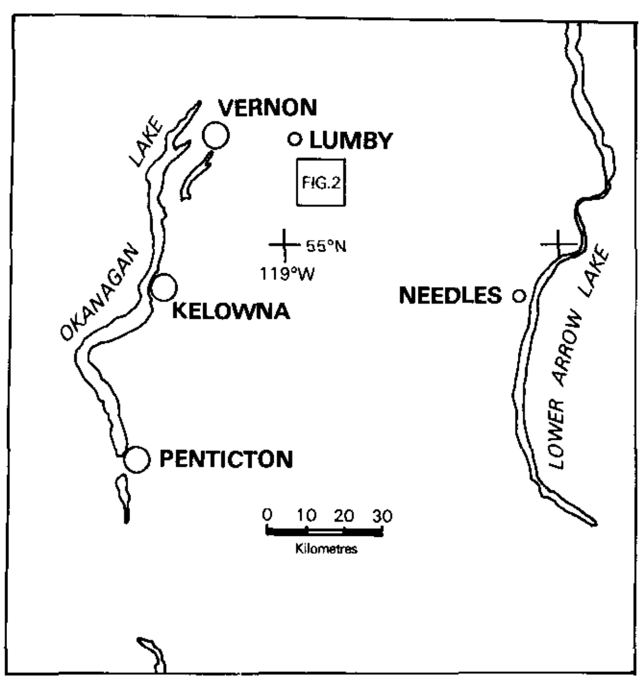

Figure 6-4-1. Location of Harris Creek.

STUDY REACH

A study reach, approximately 2 kilometres long, 25 kilometres from the watershed, was selected for detailed sampling (Figure 6-4-2). The major source of gold in the drainage sediments is unknown, but is probably at least 3 kilometres upstream from the uppermost sampling location. The reach has a fairly constant energy slope of 0.03 and there are no major confluences. The channel shows low sinuosity meandering with well-developed gravel point bars, which become channel bars during peak spring discharges (>10 cubic metres per second). The south bank is underlain by resistant granodiorite which produces bedrock riffles on south convex bends; the north bank is underlain by recessive argillite and basaltic volcanics.

SAMPLING METHODOLOGY

In an initial study of Harris Creek, Day and Fletcher (in press) found that at least 60 kilograms of minus 10-mesh (2 millimetres) sediment were needed to provide sufficient −150+200 and

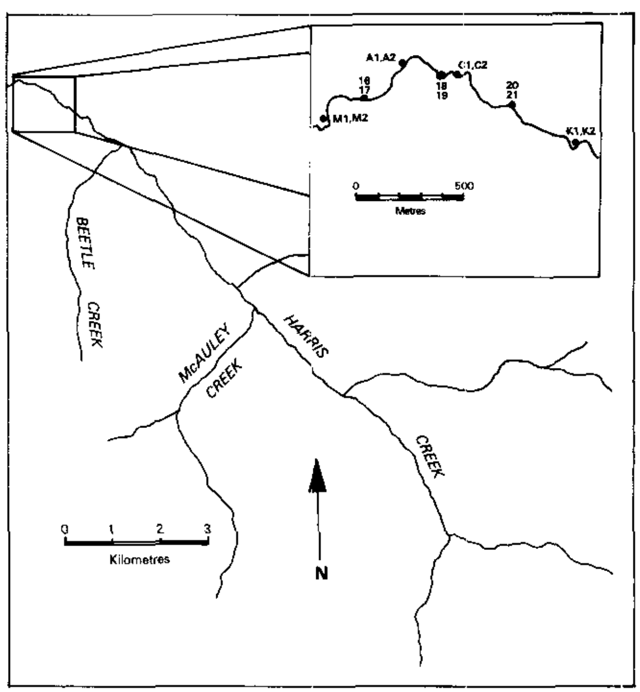

Figure 6-4-2. Catchment basin of Harris Creek, upstream from the study reach. Inset, sampling sites on the study reach. Numbers = November 1985 samples, letters = June 1986 samples.

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−200+270-mesh sediment to give relative errors better than ±50 per cent at the 95 per cent confidence level for the gold analyses. This estimate is derived from the Poisson distribution and corresponds to having approximately 20 particles of gold in the fractions being analysed. The standard sample in this study therefore consisted of 60 kilograms (dry weight) of minus 10-mesh sediment, an amount which fills two 23-litre pails.

In November 1985, six samples were taken at three point-and-channel bar sites on the study reach (Figure 6-4-2). In the following June, a slightly greater length of the stream was sampled with eight samples collected from four sites (Figure 6-4-2). The three initial locations could not be resampled as discharges were much greater in the spring, due to meltwater runoff. Samples were taken at the upstream and downstream ends of bars, representing erosional and depositional environments respectively. Field sampling technique consisted of selection of an area of stream bed having homogeneous texture, followed by wet-sieving of sediment through a 2-millimetre nylon sieve. Loss of fine sediment from the sample was prevented by catching the overflow from the pail in an aluminum tub. The +2-millimetre fraction was retained and weighed. As much as 300 kilograms of sediment were processed at each erosional site but on average, only 60 kilograms were processed at the depositional sites (Table 6-4-1).

**TABLE 6-4-1.
TOTAL SEDIMENT PROCESSED FOR EACH SAMPLE TO YIELD 23 LITRES OF MINUS 10-MESH**

November 1985			June 1985		
Number	E/D[1]	Weight (kg)	Number	E/D	Weight (kg)
16	E	243	M1	D	70
17	D	162	M2	E	147
18	D	70	A1	D	62
19	E	386	A2	E	231
20	D	57	C1	D	134
21	E	475	C2	E	282
			K1	D	68
			K2	E	236

[1]E = erosional; D = depositional.

SAMPLE PROCESSING

Samples were dry-sieved to eight fractions, using a Rotap, then manually wet-sieved to clean up the finer fractions. Heavy mineral concentrates were prepared for two fractions (−150+200-mesh and −200+270-mesh) using methylene iodide (specific gravity = 3.3) followed by separation of magnetic minerals with a hand magnet. Magnetic minerals were separated from −70+100-mesh and −100+150-mesh fractions using an induced magnetic separator and hand magnet without first producing a heavy mineral concentrate. Magnetic minerals were removed from minus 270-mesh material by creating a slurry with water and stirring with a magnetic bar. Nondestructive neutron activation analysis was used to determine gold in nonmagnetic heavy mineral concentrates of the −150+200 and −200+270-mesh fractions and nonmagnetic minus 270-mesh sediment.

RESULTS AND DISCUSSION

When interpreting the data, it should be noted that samples taken from erosional environments consist mostly of material taken from the stream bed subsurface and are considerably finer than the surface layer in contact with fast-flowing water. During winnowing, fine sediment is removed from the surface, creating an armour which prevents erosion of the subsurface. The sample is therefore not representive of the stream bed produced by stream processes acting at the time of sampling. Conversely, fine sediment samples taken from depositional sites principally represent a composite of products of erosional processes that occurred immediately upstream from the sampling location during the waning stage of the last freshet.

Magnetic mineral concentrations are best summarized as means and coefficients of variation (CVs) for the sites sampled in each season (Table 6-4-2). Although abundance of magnetic minerals is similar in minus 270-mesh material from both environments, results indicate that depositional sites show less variability in abundance of magnetic minerals between fractions. In particular, depositional sites do not contain the high concentrations of magnetic minerals found in the coarser sized fractions from erosional sites. This probably reflects a lack of supply to depositional sites as coarse magnetic mineral grains are trapped and concentrated at erosional sites. Conversely, as described in other heavy mineral studies (Saxby and Fletcher, in press), finer magnetic minerals are less susceptible to density segregation and become more uniformly distributed between environments. This is also consistent with the well-developed trend for magnetic mineral CVs for both environments which shows a systematic decrease from coarse to fine size fractions in the November samples. Failure to detect this trend in June suggests that immediately after the spring meltwater flood, the sediments have not yet developed systematic grain size-density relationships.

**TABLE 6-4-2.
SUMMARY STATISTICS FOR MAGNETIC MINERAL CONCENTRATIONS**

	November 1985[1]				June 1986[2]			
	Erosion		Deposition		Erosion		Deposition	
Fraction	$\bar{X}$[3]	CV[4]	$\bar{X}$	CV	$\bar{X}$	CV	$\bar{X}$	CV
−70+100	10.9	91	2.5	50	13.9	48	1.7	33
−100+150	10.5	73	3.9	34	12.4	39	2.8	43
−150+200	6.1	64	3.0	15	9.9	58	3.2	48
−200+270	4.2	42	2.4	8	4.9	42	3.1	19
−270	2.4	24	1.6	33	1.4	35	1.1	33

[1] Three sites (six samples).
[2] Four sites (eight samples).
[3] Mean of magnetic mineral concentrations (%) calculated on untransformed data.
[4] Coefficient of variation (%).

Data for gold are arranged in the same way in Table 6-4-3. For the −150+200 and −200+270-mesh fractions, it is apparent that although gold is not eroded and transported to depositional sites, average concentration differences (up to approximately 100 times) are very much greater than those associated with even the coarsest magnetite (Table 6-4-2). This is consistent with earlier observations that the tenor of heavy mineral enrichments increases with the density of the mineral concerned (Saxby and Fletcher, in press).

Coefficients of variation for gold include not only between-site variability (reflecting the wide range of hydraulic conditions observed in depositional environments), field sampling and laboratory processing errors, but also high errors associated with sampling of rare grains as described by the Poisson distribution. Hence, coefficients of variation greater than 100 per cent, without obvious seasonal trends, are associated with the low gold concentrations and extreme rarity of gold in −150+200-mesh and −200+270-mesh

TABLE 6-4-3.
SUMMARY STATISTICS FOR GOLD CONCENTRATIONS

	November 1985[1]				June 1986[2]			
	Erosion		Deposition		Erosion		Deposition	
Fraction	$\bar{X}^3_L$	CV[4]	$\bar{X}_L$	CV	$\bar{X}_L$	CV	$\bar{X}_L$	CV
−150+200	170	14	4.5	134	383	18	2.2	192
−200+270	122	23	1.8	449	454	38	4.0	134
−270	21	25	24.0	30	27	32	6.6	34

[1] Three sites (six samples).
[2] Four sites (eight samples).
[3] Mean of gold concentrations (ppb) calculated for whole fraction using log transformed data.
[4] Coefficient of variation (%).

sediments from depositional environments. In contrast, despite their low gold content, CVs for gold in minus 270-mesh sediments are only about 30 per cent. As discussed by Day and Fletcher (in press), this reflects the large number of minus 270-mesh gold particles (average diameter 20μ) required to provide even these low gold concentrations. Thus, providing anomalous concentrations of gold are present in this size range, minus 270-mesh sediment can provide an adequate exploration sample without the need to prepare a heavy mineral concentrate.

Although depositional sites show no obvious trends in magnetite and gold content between November and June, average concentrations in all but the minus 270-mesh fraction of erosional sites show notable increases from two to fourfold for gold. However, because of differences in sampling sites caused by high water in June, there is insufficient evidence to determine how these differences reflect true seasonal variations in erosion and deposition. Bulk sediment samples are now being collected, at regular time intervals from erosional and depositional environments associated with a single bar, in an attempt to resolve this problem.

CONCLUSIONS

Results at this early stage show that:

(1) The highest concentrations of high density minerals are found in erosional environments. A large volume of sediment (up to 450 kilograms) must be processed in order to obtain the sample.

(2) The lowest variability between sites and between erosional and depositional environments occurs in the minus 270-mesh sediment. This fraction can be conveniently analysed without preparation of a heavy mineral concentrate.

ACKNOWLEDGMENTS

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