CHEEKYE RIVER MUDFLOWS

By W. C. Jones

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Introduction

The purpose of this investigation was to locate the source of debris deposited in large quantities in the Cheakamus River by the Cheekye River after a heavy rainstorm in August, 1958 and to determine by what process this material was transported. To this end, 2 days were spent in the area and several days in the office examining topographic and geological maps and aerial photographs.

General Geology

In order to understand the origin and transporting mechanism of this mudflow-type slide a knowledge of the geology of the area is necessary. The accompanying plan (Figure 1) outlines the geology of the Cheekye River area.

Mount Garibaldi is an extinct volcano which was built by glowing avalanches of hot debris during an uninterrupted series of Peléan eruptions.* Evidence indicates that these eruptions occurred during late Pleistocene time when ice filled the Squamish Valley to an elevation of approximately 4,300 feet. Over 1 cubic mile of tuff breccia rubble was deposited on the west and southwest slopes and

*Mathews, W. H. (1952): Mount Garibaldi, A Supraglacial Pleistocene Volcano in South-western British Columbia, Am. Jour. Sc., Vol. 250, No. 2, pp. 81-103.

this material now covers the steep-walled Cheekye Basin down to an elevation of about 3,000 feet. Its depth is reported to be up to 2,300 feet. This unconsolidated, highly porous tuff breccia consists of red to grey dacite fragments ranging in size from dust to blocks up to 50 feet in diameter. Part of it was laid down on the eastern margin of the Squamish Valley glacier. The tuff breccia overlies greenish schistose quartz diorite which, according to Mathews (1952), has been converted to silvery rust-streaked schists and rusty clays up to depths of 20 feet. These silvery schists and rusty clays, which were formed at the time of deposition of the breccia, are apparently continuous under the tuff breccia. The clays play an important role in the formation of the slides.

With the waning of the ice of the last ice age, part of the tuff breccia which had been deposited on top of the ice in the Cheekye Basin was undermined, and great landslides carried large quantities of material through the pre-glacial Cheekye gorge and deposited it as weakly consolidated material on the glaciated, hummocky rock surface immediately below the gorge (see Figure 1). Successive slides deposited debris against the margin of the waning ice with the result that a series of crude terraces

was formed. This slide debris covers an area of approximately 3 square miles and probably reaches depths of several hundreds of feet locally. It consists of about 30 per cent sub-angular grey to red dacite boulders ranging in size from 2 inches to 6 feet in a well-graded ground mass of dacite silty sand (see Figure 3, sample No. 1). This material is generally unsorted although a crude stratification occurs locally which indicates that water played a part in its deposition.

Since the disappearance of the ice, slides have continued to the present day and a gently sloping fan-like deposit has been formed immediately west of the terraces. It now occupies an area of about 4½ square miles and extends to the Cheakamus River (see Figure 1). It extends from an elevation of 100 feet to 500 feet and probably reaches depths of several hundreds of feet locally. This material is similar in composition to the above described slide debris except that the slide debris has a greater amount of fines (see Figure 3, sample No. 2). This indicates that water has played a more important role in the formation of the recent fan with the resultant washing out of a higher percentage of the fines. The rate of growth of this fan has been so rapid that the Cheakamus

River has been forced in part against bedrock to the west. The fan is still in an active stage of formation.

Cheekye River

The Cheekye River is best considered as 3 distinct units; the headwaters, which lie in the source of the slide rubble, a canyon section near the middle part of its course which acts as a funnel through which the slide rubble pours and the section from the canyon to the mouth which is now primarily an area of deposition especially in its lower reaches. The headwaters are a fine-textured pattern of branching tributaries lying in the steep Cheekye basin. These streams have incised themselves into the unconsolidated tuff breccia and run at gradients of up to about 1,000 feet per mile in their upper reaches. Their depths of incision are relatively shallow which indicates that landslides rather than normal stream erosion is the chief agent in moving material from the basin. In the 2 mile long canyon (see Figure 1) the river runs between steep rock walls at an average gradient of about 430 feet per mile. The floor, which is about 150 feet wide, is covered with slide rubble and logs and the river wanders irregularly through this material. In the section between the lower end of the canyon and the Cheakamus River, the

Cheekye runs in a channel averaging about 200 feet wide which was scoured by a recent mudflow (see Figure 2 for gradients in this section). The cut-banks generally do not exceed about 12 feet in height and consist of coarse slide materials. One old slide scar occurs on the bank near the lower end of the canyon but this slide has not contributed material to the river for many years. Occasional rock outcrops border the river for lengths of up to several hundreds of feet. A former mudflow scour channel up to 200 feet wider than the one in which the river now flows occurs about 6 feet above the present channel and can be traced intermittently for the entire length of this section of the river. Although material deposited by mudflows lies in the entire length of the present channel, the maximum deposition is from the mouth to about ½ mile upstream where the gradient is about 190 feet per mile. From the upstream end of this reach to the canyon, the gradient averages about 330 feet per mile.

Mudflow of August, 1958

Following a sudden rainstorm in August, 1958, thousands of yards of tuff breccia debris and logs rushed down the Cheekye River and built a 15-foot high dam across

the Cheakamus River immediately above the mouth of the Cheekye. Most of this dam still remains. Eye witnesses say that the mudflow moved at about 5 miles per hour near the mouth of the Cheekye, flowed for several minutes, and appeared to be about 10 feet high. The Cheekye River was temporarily diverted southward but when the flow had subsided, it reverted to its original channel on the north side of the scour channel. The floor of the scour channel was left covered with silt and sand-covered boulders and logs but since that time, the fines have been largely washed away. Figure 3, sample No. 3 illustrates the grading of sand now forming small bars at the mouth of Cheekye River.

The debris deposited in the Cheakamus River temporarily diverted the main current to the east bank immediately downstream from the mouth of the Cheekye and caused rapid erosion which endangered an auto court in that vicinity. The bed of the Cheakamus River was aggraded several feet for several hundreds of yards downstream and the 1959 spring run-off carried remnants of the mudflow debris from the Cheekye River into the Cheakamus further aggravating the situation. It is reported that water washed over the deck of the new log highway bridge for a brief period this spring. Local

residents report that the erosion pattern of the Squamish River also changed locally due to the abnormal amount of material contributed to it by the Cheakamus River this spring.

Mechanism of the Mudflow

From the above observations, it appears that the mechanism of the mudflow was as follows: The heavy rain saturated the tuff breccia in the Cheekye basin; the water percolated downward through this highly porous material onto the underlying clay layer; either the shear strength of the clay was sufficiently lowered or the surface was made sufficiently slippery to allow a mass of tuff breccia to slide off in one or more areas; this loosened material cascaded down the headwater tributaries with initially high velocities. The mass had sufficient momentum and fluidity to enable it to traverse the entire length of the river yet it also possessed sufficient viscosity and density to carry blocks up to several feet in diameter on gradients of 190 feet per mile; it rode essentially on top of the old stream channel, eroded material from the banks and to a lesser extent from the bed but also deposited material over a greater part of the bed. Deposition by this mechanism has exceeded river erosion which

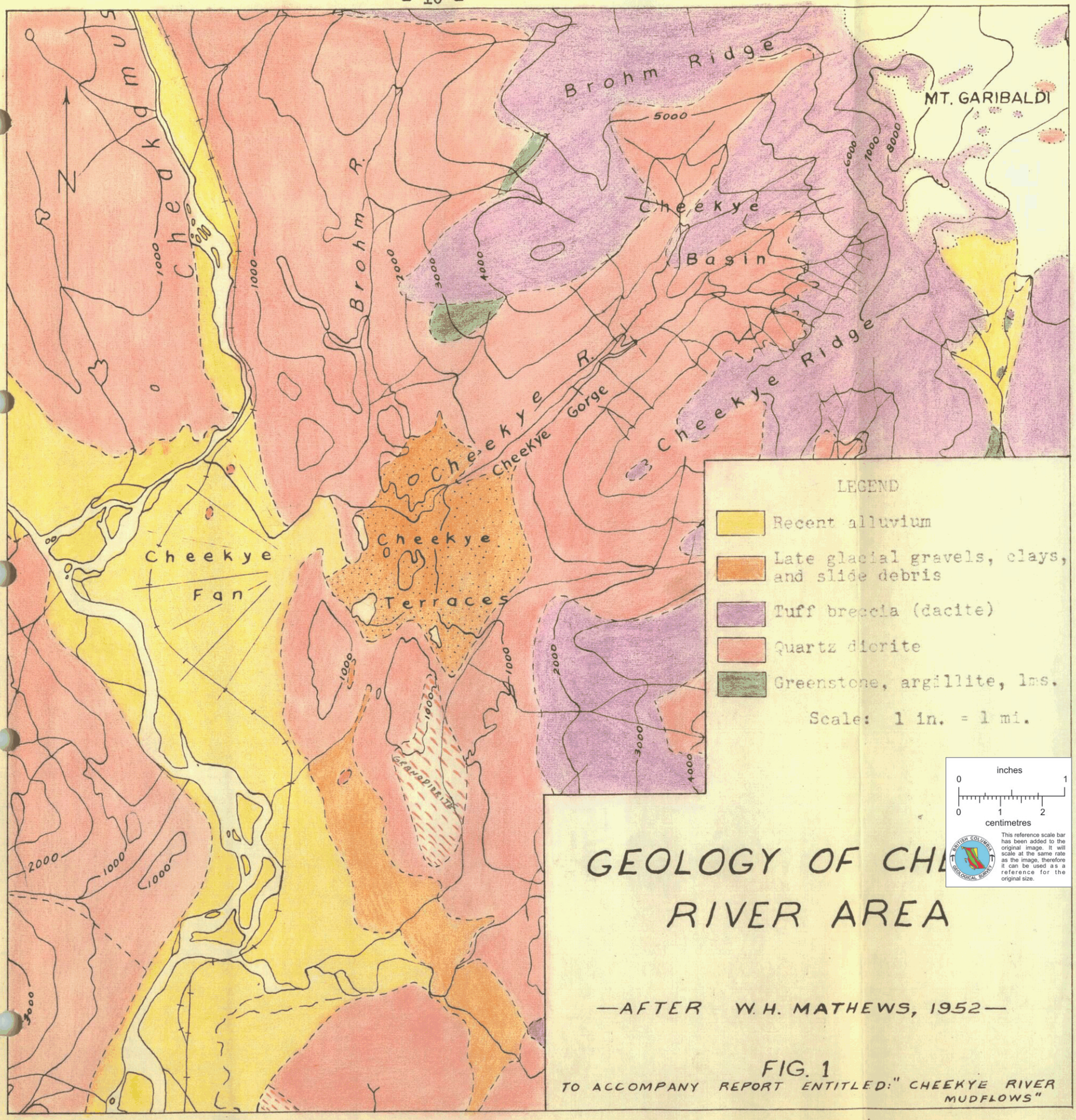
accounts for the relatively shallow depth the river has incised into this material.

Local residents report that the last mudflow of this kind on the Cheekye River occurred about 30 years ago and it was of sufficient volume to divert the Cheakamus River into a channel farther west near the mouth of the Cheekye. Construction of a levee along the west side of the Cheakamus returned the river to its original course. The elevated scour channel along the Cheekye River no doubt marks the path of this old slide. It is covered with coarse, sub-angular dacite boulders between which poplar trees which appear to be up to about 30 years old grow.

These mudflows constantly tend to extend the recent fan westward. This fact is demonstrated by the gradients of the Cheakamus River in this area. Between the junction of the Cheakamus with the Squamish and the mouth of the Cheekye, the average gradient is about 75 feet per mile while from the mouth of the Cheekye to about 3½ miles upstream, the average gradient is only about 20 feet per mile. Above this point the average gradient is about 75 feet per mile. Theoretically, if the amount of debris brought down along the Cheekye River exceeds the amount

which the Cheakamus River can carry away, in time the Cheakamus River will be dammed near the mouth of the Cheekye and a lake will be formed upstream on the Cheakamus. Barring the possibility of a mudflow considerably larger than normally experienced, dredging of the river bottom near the mouth of the Cheekye after each mudflow should prevent this from happening. However, sufficient debris has been brought down recently and probably will be in the future to raise the bed of the Cheakamus River enough to cause flooding of the flats below the mouth of the Cheekye.

Judging from the extent and thickness of the tuff breccia remaining in the Cheekye basin, millions of cubic yards of this material is still available to form mudflows and no doubt mudflows will occur from time to time. Their magnitude and frequency is unpredictable, however, as their occurrence appears to depend upon sudden abnormal rainstorms rather than upon normal autumn rainfall peaks.



GEOLOGY OF CHE
RIVER AREA

—AFTER W.H. MATHEWS, 1952—

FIG. 1
TO ACCOMPANY REPORT ENTITLED:" CHEEKYE RIVER MUDFLOWS"

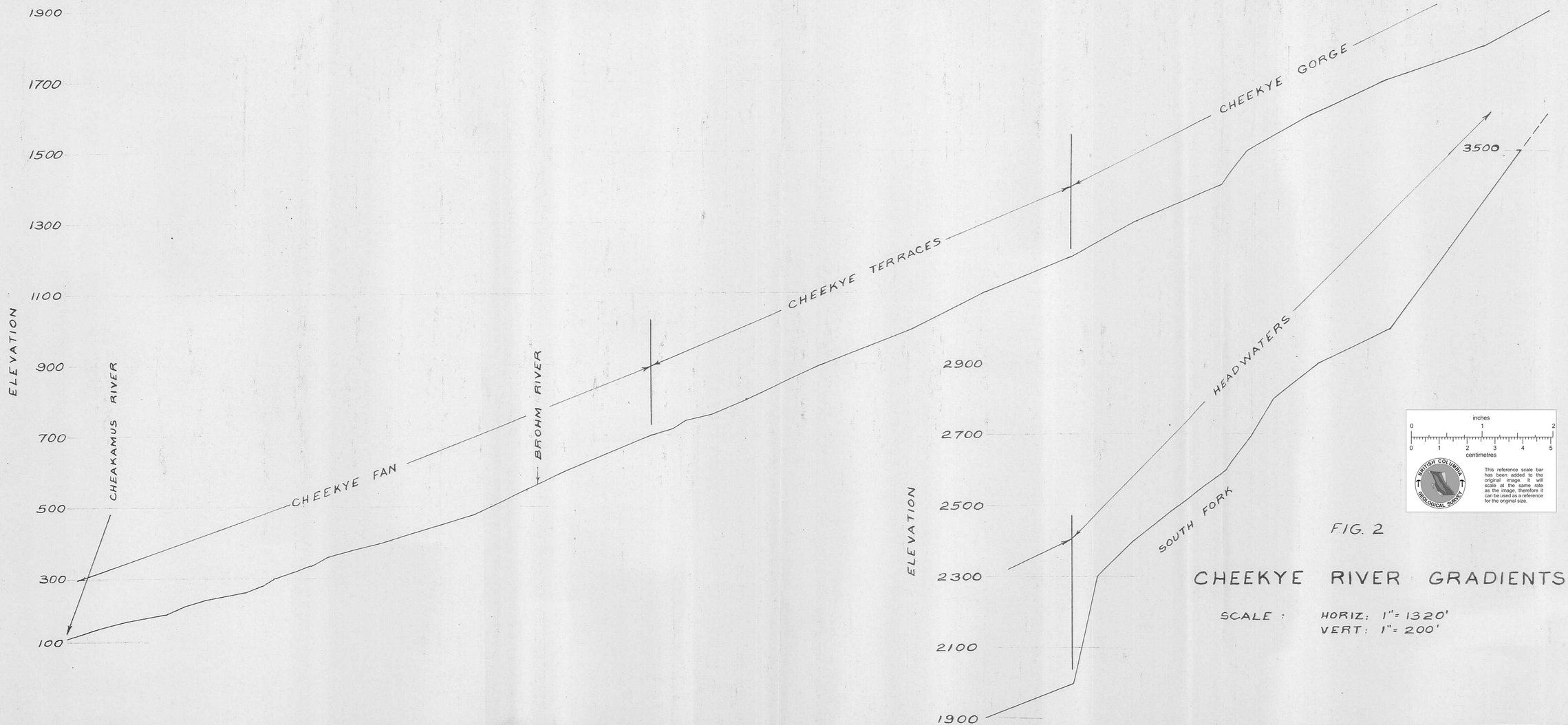


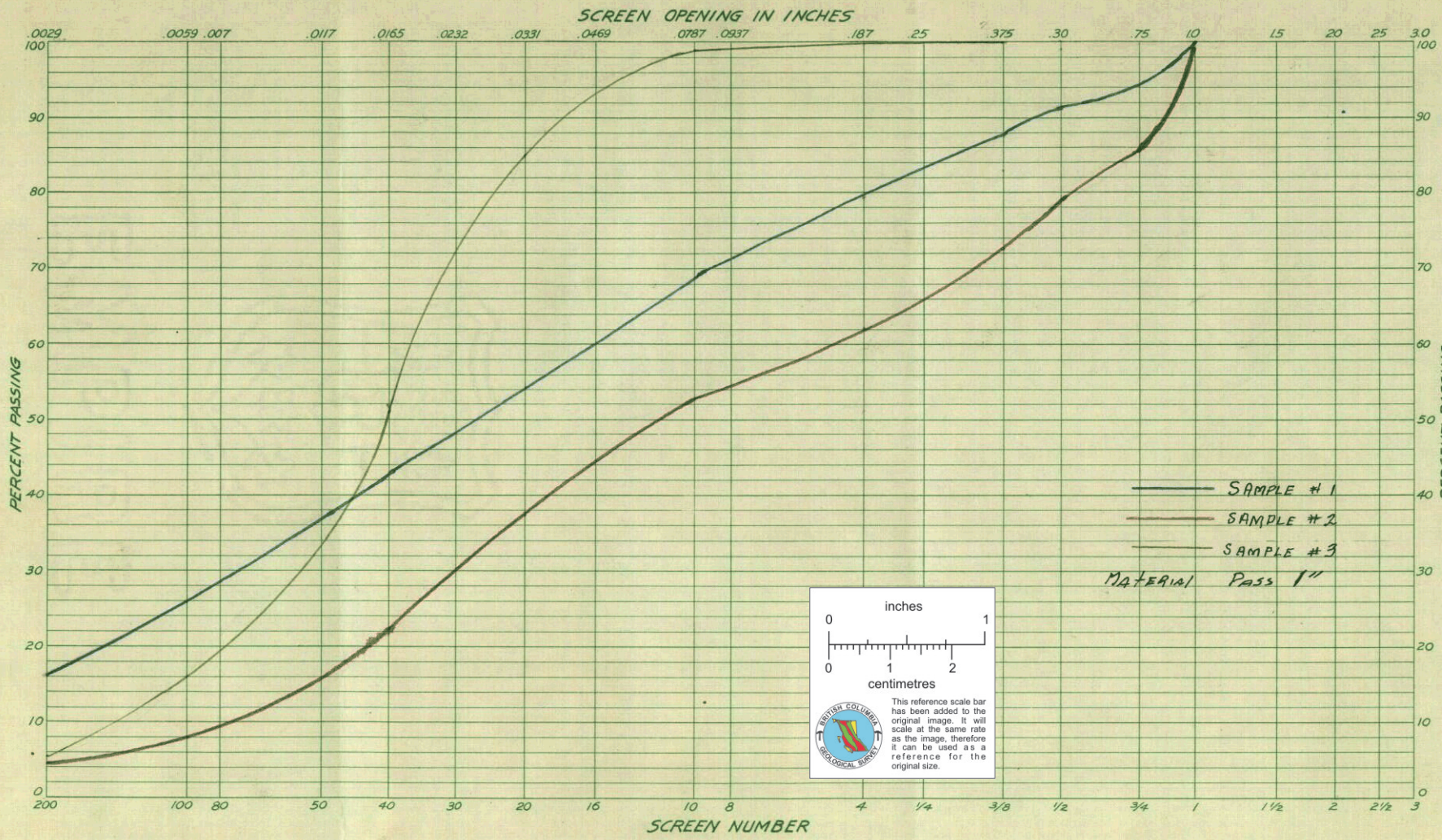
FIG. 2

CHEEKYE RIVER GRADIENTS

SCALE : HORIZ: 1" = 1320'
VERT: 1" = 200'

AGGREGATE CHART

DEPT. OF HIGHWAYS B.C.



SAMPLE NO.					SAMPLE NO.				
PASSING	RET. ON	LBS.	%	TOTAL % PASSING	PASSING	RET. ON	LBS.	%	TOTAL % PASSING

0

IDENTIFICATION	
PROJECT ~~NO.~~	DEPT. OF MINES
SECTION	
LOCATION	
STATION PLACED	
SAMPLE OF	
SAMPLED BY	DATE
SCREEN ANALYSIS BY HW	DATE 9-7-59