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STREAM-TRENCH SYSTEMS in East-Central Alberta

by

C. P. GRAVENOR AND L. A. BAYROCK

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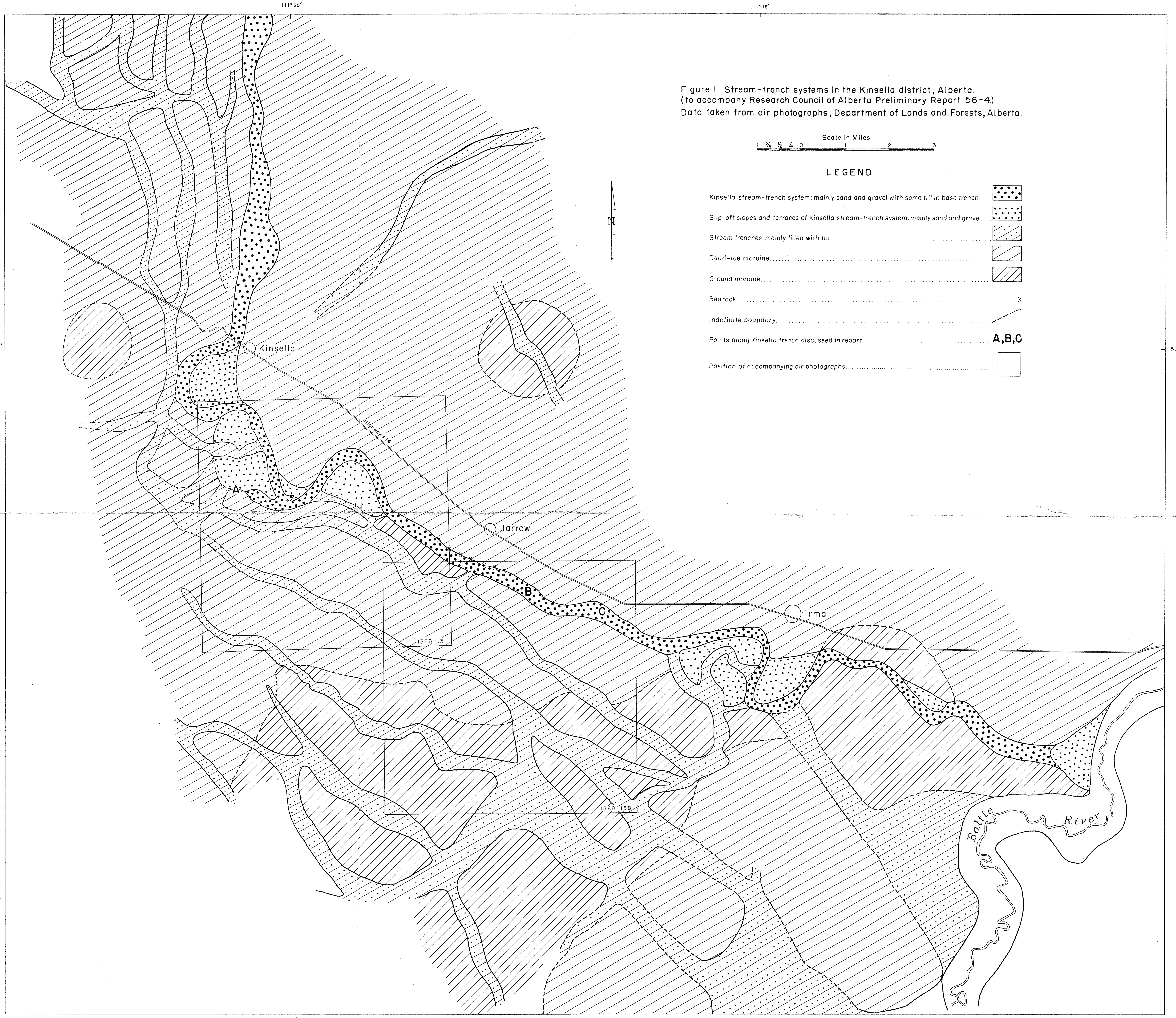

Figure 1. Stream-trench systems in the Kinsella district, Alberta.
(to accompany Research Council of Alberta Preliminary Report 56-4)
Data taken from air photographs, Department of Lands and Forests, Alberta.


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C. P. Gravenor and L. A. Bayrock

Research Council of Alberta
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INTRODUCTION

It has been known for some time that the drainage patterns of Alberta present some abnormal features which are rather difficult to explain by diversions caused by ice advance and retreat, or by the effect of preglacial stream courses (Bretz, 1943 and Warren, 1944). Recently there has been found in the Alliance-Kinsella district of east-central Alberta a confused system of interconnected debris-filled channels which are intimately tied to the drainage problems of the larger stream courses of Alberta. Similar channels -- or stream-trenches -- have been noted on air photographs of the Stettler district, and it seems probable that the conditions which caused the stream-trenches in the Kinsella district were widespread over central Alberta.

The fact that most of the stream-trenches are filled with moraine and stratified materials suggested to the authors that the trenches antedated the last glacial advance. A detailed examination of the Kinsella district, however, has provided evidence to suggest that these debris-filled trenches are contemporaneous with the retreat of the last ice and formed in openings in stagnant ice. The realization of the age of these trenches does much to clarify some of the major problems of drainage in Alberta.

Acknowledgments

The authors are indebted to Dr. P. S. Warren of the University of Alberta for his encouragement and suggestions on glacial problems in

Western Canada. Thanks are also due to the Alberta Department of Lands and Forests for providing the accompanying photographs at low cost. Mr. S. J. Groot, draftsman-compiler for the Research Council of Alberta, prepared the figure showing stream-trench systems in the Kinsella district.

Conditions of Ice-retreat in Western Canada

Before considering the nature and origin of the stream-trenches it would seem advisable to review first the present status of knowledge on the nature of the last ice-retreat in Alberta.

Reports from various areas in Western Canada and the north-central United States suggest that large-scale stagnation was a dominant method of ice retreat (Christiansen, 1956; Gravenor, 1955; Gravenor and Bayrock, 1955; Bayrock, 1955; Townsend and Jenke, 1951). Prairie mounds, till crevasse fillings, a thin covering of sand over ground moraine and ablation or dead-ice moraine reported from various areas in the west all suggest widespread stagnant ice. Recently Christiansen (1956) has recognized the similarity between the dead-ice moraines of Denmark and those of Western Canada. This is an important observation and suggests that glacial geologists working in Western Canada should look to Europe for analogous situations, rather than to eastern North America.

The debris-filled and open trenches in east-central Alberta described in this report are similar in many respects to the Rinnentäler and Urstromtäler of Europe. Hence, although the solutions offered in this report are those given to fit the facts in the Kinsella district of Alberta, the concepts are similar in some respects to those given for certain drainage complexities of Europe. Flint (1947, p. 167) suggests that some of the ice-marginal drainage of southern Alberta is similar to the stream-trench systems of Europe. The drainage complexities described in the present report, however, are due largely to streams flowing through stagnant ice and hence differ from the ice-marginal drainage of parts of south-central and southern Alberta.

GENERAL NATURE OF STREAM-TRENCHES

The stream-trenches of east-central Alberta can be divided into two types which are genetically similar, (a) those which are filled with moraine and are recognized on air photographs by the alignment of kettle lakes in the base of the valleys, and (b) broad open troughs which contain little or no present-day drainage. The latter type is most common in areas of thin ground moraine, and bedrock is frequently exposed in the valley walls. The former type is most common in areas of dead-ice moraine (ablation moraine) and bedrock is found at a considerable depth below the base of the valleys. There are all gradations between these two types.

In some cases the moraine-filled type of trench is quite difficult to recognize on the ground where the level of debris filling the trench is very near the level of the surrounding dead-ice moraine. Where the open type trenches enter areas of very thick dead-ice moraine, their borders become indefinite and in some cases impossible to follow even on air photographs (see trench north of Jarrow, Fig. 1).

In plain view the trenches present a confused pattern of parallel and intersecting drainage. Where one trench has cut across and has eroded the deposits of a previous trench, it is possible to establish the relative ages of the trenches. Unfortunately it has not been found possible to date all the trenches by this method. It is fairly certain, however, that the trenches were all cut during the stagnation of the last ice and differences in age are due only to cracks in the stagnant ice opening at slightly different times.

The stream-trench pattern in the Kinsella district has a rough north-south alignment north of Kinsella and swings to a southeasterly direction southeast of Kinsella. This south to southeasterly alignment of stream-trenches seems to be fairly general in the part of Alberta studied. The relationship of the stream-trench direction to the direction of ice advance is as yet unknown, but there are suggestions of south-easterly ice-movement directions in the Sedgewick area, southwest of Kinsella.

The relationship of the stream-trenches to the major drainage patterns of Alberta is only vaguely understood, but certain inferences, which will be presented later in this report, can be drawn from the relationship of the trenches to the Battle river.

Kinsella Stream-trench

There are four major problems in the interpretation of the stream-trench systems, (a) the time at which the trenches were cut, (b) the time of infilling of some of the trenches, (c) the reason for the intricate pattern of drainage, and (d) the relationship of the trenches to present-day major drainage systems. It is evident that if the first problem can be answered -- the time of cutting -- then the answers to the other questions must follow in logical sequence.

It is believed that the Kinsella stream-trench offers the solution to the time of cutting. There are three key points,(A, B, and C, Fig. 1) along the Kinsella stream-trench, which will be discussed consecutively.

Point A: This point lies on the south end of a large gravel slip-off slope, slopes upward toward the moraine on the west and downward toward the main river channel on the east. The gravel in the slope shows cut-and-fill structures and cross-bedding. Sorting of the gravel is moderately good with rounded pebbles and boulders ranging in diameter from one-half inch to three feet. The large boulders may be in part ice-rafted, but large accumulations of such boulders, clearly transported by running water, occur in parts of the western portion of the slope. The boulders are composed mainly of gneisses, granites and quartzites.

The important facts regarding this slip-off slope are, (a) at point A the gravel lies at a slightly higher elevation than the dead-ice moraine to the south, and (b) there is no till on top of the gravel.

Point B: At this point the Kinsella stream-trench is blocked by moraine. Small amounts of water may trickle over this blockage from the upper salt lake at certain times of year, but not enough to cut a well-defined outlet channel. Knobs of brown-grey clayey till 15 to 25 feet in height cover the valley at this point, and careful field examination shows that this till is not the result of recent slump.

Point C: At this point there is a moraine crossing which, although similar to point B, is more extensive and displays quite rough morainic topography. Recent drainage has cut a very small channel into this moraine. An examination of the accompanying photograph No. 1368-13b shows that the valley wall of the Kinsella stream-trench lies about one-third of a mile north of the present-day stream and that the intervening space is moraine-covered.

The following conclusions are drawn from the above facts:

(1) During the formation of the high-level gravels in the Kinsella stream-trench, ice must have stood just south of point A in order to hold the water above the level of the moraine.

(2) The lack of till above the gravel shows that no readvance took place after the gravels were formed and that this part of the stream-trench was open to the atmosphere at the time the gravels were formed.

(3) The moraine crossings at points B and C were deposited after the stream-trench was cut into the soft underlying bedrock.

Conclusion (3) would suggest that the stream-trench was built prior to the last ice advance, yet it is quite clear at point A and north of point A that the stream-trench was built during the stagnation stages of the last glaciation. There is no evidence to suggest that an extremely local readvance of the ice covered points B and C. The only logical conclusion is that the stream-trench cut through deep, narrow ice walls at points B and C and then, when the stream-trench cutting had ceased, the ice and its included debris slumped into the stream-trench leaving the hummocky moraine behind.

An analysis of the pattern and erosion of the stream-trenches neighboring the Kinsella stream-trench shows they were cut both before and after the Kinsella stream-trench. Thus it is fairly certain that all of the stream-trenches were cut during a stagnant or dead-ice phase of the last glacier and were infilled by debris-choked ice walls slumping into the trenches.

This conclusion is in agreement with observations made on the formation of prairie mounds, till crevasse fillings and dead-ice moraine. They are all the result of stagnation of debris-choked ice.

The reason for the intricate, interlocking pattern is now clear. Water which cut the stream-trenches was flowing through cracks in the ice; when the ice walls collapsed in the trenches or lower outlets were found, the trenches were abandoned in favor of new ones. This also accounts for the confusing age-relationship between the stream-trenches. The problem of the relationship of the stream-trenches to major present-day drainage will be discussed next.

RELATIONSHIP OF THE STREAM-TRENCHES TO THE BATTLE RIVER VALLEY

It should be pointed out that until the full length of the Battle River course has been studied its complete history will not be known. However, certain inferences can be drawn from the nature of the Battle River valley in the Alliance district, the Hardisty district and at Gwynne. Although some parts of the Battle River course may have been determined by preglacial channels, the present report deals mainly with its glacial history.

When the last ice had retreated just east of Edmonton, waters issuing from the west along the North Saskatchewan were blocked by the ice and ponded in the Edmonton basin. Added to this water from the west was the meltwater from the ice. This water in the Edmonton basin apparently spilled to the south along a major outlet which passes through the village of Gwynne (Bretz, 1943). There is no drainage in this large coulee at the present time. The outlet -- herein called the Gwynne outlet -- continues southward and eastward to the Alliance district, then turns abruptly to the northeast towards Hardisty, and crosses a high part of the area. The present Battle river occupies that portion of the Gwynne outlet from Gwynne eastward.

The stream-trenches in the Alliance-Kinsella area discharged towards the south and southeast, and apparently joined the Gwynne outlet in its northeast course through the Hardisty district. Southeast of the Gwynne outlet in the Hardisty district, however, there are outwash flats, stream-trenches and coulees which indicate that the drainage from the stream-trenches in the Alliance-Kinsella area discharged across the Gwynne outlet and continued on their southeast course, possibly joining the Kerrobert outlet in Saskatchewan. High-level gravel terraces on the Gwynne outlet were built in part by the drainage from the stream-trenches, and indicate that the northeast course of the Gwynne outlet through the Hardisty district was cut either prior to or during the stream-trench phase. However, the Gwynne outlet in the Hardisty district only carried a small portion of the total stream-trench drainage and most of the drainage continued towards the southeast across the Gwynne outlet. Apparently the northern portion of the Gwynne outlet was blocked by ice which forced drainage to the southeast. In other words this northeast trending portion of the Gwynne outlet through Hardisty is only a part of the interconnected stream-trench system.

The gravel terraces on the Gwynne outlet which were deposited in the stream-trench, were later dissected by drainage that probably moved through the Gwynne outlet from Lake Edmonton. This means that ice must have stood in the area east of Edmonton and blocked the North Saskatchewan slightly after the time when the stream-trench system was formed at Kinsella. The implications are now far-reaching and would suggest that the northern portions of the Buffalo Lake dead-ice moraine were formed at the same time as the Viking dead-ice moraine, and that the ice retreated in a general north-northeasterly direction. By applying a similar line of reasoning to the other moraines of central Alberta -- the Duffield and Coteau moraines -- it may be possible to work out their relative ages. The present suggestion is that they may all be the result of stagnation of the last ice and the formation of portions of the different moraines may be contemporaneous. It is also suggested that the reason for some of the major drainage systems of Alberta crossing high ground areas when lower ground was apparently available (Bretz, 1943), is that the initial cutting was done through ice walls.

ECONOMIC SIGNIFICANCE OF STREAM-TRENCHES

The stream-trench systems of east-central Alberta have considerable importance economically. The open type of trench supplies much of the gravel for east-central Alberta (i.e. the enormous gravel pits at Kinsella and at Hardisty), and the moraine-filled type of stream-trench supplies groundwater. In most moraine-filled trenches the relatively impermeable moraine is underlain by sand and gravel which in turn are underlain by relatively impermeable bedrock. Thus the conditions for artesian systems are satisfied, and wells in these valleys have been found to be artesian.

The fact that most of the stream-trenches can be readily located on air photographs greatly facilitates prospecting for gravel and groundwater in this area.

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