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CANADA
DEPARTMENT OF MINES

GEOLOGICAL SURVEY BRANCH

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, ACTING DIRECTOR.

REPORT

ON THE

LANDSLIDE AT NOTRE-DAME DE LA SALETTE
LIÈVRE RIVER, QUEBEC

BY

R. W. ELLS, LL.D

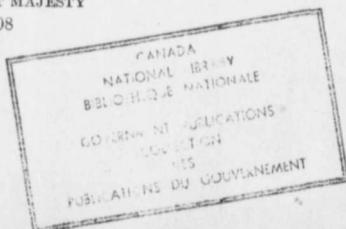


OTTAWA

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This landslide, which occurred on the morning of Sunday, April 6, 1908, was, as compared in area with several others which have happened in the province of Quebec, of somewhat small dimensions, but as regards the attendant loss of life is the most disastrous on record in eastern Canada.

The locality affected is the eastern portion of lots 1 and 2 of the river range of Portland west, about six miles north of the Little Rapid lock on the Lièvre river, now known as Poupore; near which place, in October, 1903, another somewhat extensive slide occurred; which was described and mapped in the Summary Report of that year, by the present writer.

The Salette slide is comparatively narrow, beginning on the bank of the stream, at the mouth of a small creek which flows in from the west at about 166 yards south of the end of the road at Chalifoux landing. The south end of the affected area is at, or near the line of division between lot 1 of range VI, and lot 6 of range V, on the south—owned by Camille Lapointe. The break occurred between his house—which was engulfed in the slide—and his barns; the latter remaining untouched. The length of the slide between these points along the bank of the stream is

about twenty chains, or say 1,350 feet. The line of the break is irregular, extending inland at the widest part about 400 feet, as nearly as can be now estimated, and the area involved in the slide is apparently not far from six acres. The height of the clay bank which slipped into the river was about sixty feet above the present level of the stream.

The Lièvre river has been subject to land slides for a long period of time. The clay deposits line the stream for the greater part of the distance from Buckingham village, nearly to High falls—about twenty-four miles inland; except where interrupted by occasional bluffs of granite, gneiss or limestone of the Laurantian formations.

The presence of ancient slides can be recognized readily by the usually hummocky or irregular nature of the surfaces where these have taken place, but in many cases they have been under cultivation for years, while others are covered with a growth of timber. These clay areas are bounded at a short distance, on either hand, by hills of the old rocks, often steep on the sides facing the river valley, some of which show smooth glaciated faces, caused by the passage of the glacial ice. This ice evidently followed the course of the old river channel, which must have been excavated in very early geological times.

Some of these rocky bluffs border on the river, in which cases, the portions of the shore opposite are occupied by clay deposits. Where these deposits have been undisturbed, the clay is usually homogeneous in character, bluish in colour, tough and plastic when subjected to the action of water; occurring in heavy beds, nearly horizontal in position, and with thin layers of arenaceous silt, which separate the heavy layers or strata. When saturated with percolating waters, the silty layers suddenly pass into a semi-liquid condition.

In places where former slides have occurred, the clays having been broken up, are mixed with silty material and the original surface soil; and large sheets of the clay occur with steep inclinations, some in the direction of the river.

In these recomposed deposits, the remains of forest trees—buried at the period of the original slide, can occasionally be seen projecting from the broken down face of a more recent slide.

The last of the previously recorded land slides on this river occurred on Sunday, October 11, 1903, a short distance below the lock on the canal at Poupore post office—formerly Little rapids. This was described in the Summary Report for that year. It involved an area of about ninety-five acres, extending from the foot of the mountain on the west side of the river, nearly half a mile inland, at this place, and displaced the surface to a depth of about twenty feet, to the bank of the stream. The direction of the movement was clearly northeast from the base of the mountain, but the overflow of the clay which filled the channel for about three-fourths of a mile below the lock, also occupied a considerable area on the east bank directly south of the lock. A part of this overflow was forced northward, and filled the lock itself. The river was dammed by the clay to such an extent that the back water on the stream extended to within a short distance of the High falls. The slide occurred in an area occupied by previously undisturbed clays.

This slide at Poupore was evidently caused by several days' heavy rains, by which the whole of the broad clay flat was saturated, forming a very heavy overburden upon the underlying body of clay and silt partings. At the junction of the clays with the rock of the mountain at the back, a layer of small broken rock occurred, and the rainwater descending the slopes of the hill, evidently passed downward along the line of contact, to a layer of silt at a depth of fifteen to twenty feet from the surface. This layer having reached the point of saturation, passed into the semi-liquid condition, and, with a very gradual slope to the river, the pressure of the overlying mass of clay finally reached the stage when the equilibrium of the clay mass was overcome, and the upper stratum moved forward in the direction of least resistance: which was the bank of the river. The amount of displacement measured at several points on the flat itself, seemed, as could be seen by the displaced road which traversed the area, to be about 300 feet as a maximum. The movement was not along the smooth glaciated surface of the underlying rocks, but merely along the silt planes in the clay itself.

The disaster at Salette, or Chalifoux landing, differs somewhat in character from that which occurred in 1903 at Poupore. While the original cause of the Salette clay slide may be similar to that at Poupore, namely, a descent from the hills at the back, or to the west of the village, in the recent case, the crack occurred in the surface of the soil at about 200 to 300 feet from the front on the river. The actual cause of the slide appears to have been a fissure, into which the water descended until it reached an underlying portion or stratum of blue clay which, along the edge of the break, had an exposed dip towards the river of 18 to 20 degrees—when the overlying burden of clay, silt and sand overcame the resistance and slipped forward into the river bed. The momentum of this sliding mass, starting from an elevation of sixty feet, and at such a short distance from the front of the bluff, must have been very considerable and the movement correspondingly rapid. The ice in the river was apparently unbroken at the time, and was lifted and carried forward over the east bank on which Salette village was located, at an elevation of not more than twelve to fifteen feet above the present level of the river, and which was some feet above the ordinary summer level. The rush of the ice came with such force against the village as to completely demolish the greater portion. In fact, everything within its course was destroyed: including twelve houses and some twenty-five outbuildings, which were entirely destroyed to their very foundations; while on the margin of the ice movement several other buildings were more or less damaged. On the west bank where the slide started, three houses were entirely destroyed, together with several outbuildings. The total loss of life as far as can be ascertained, was thirty-three persons.

The rush of ice was followed by a rush of water from the river, which carried portions of the ruined buildings and the bodies of villagers inland beyond the road which is parallel to the shore; depositing the *débris* at an elevation of about fifty feet above the river level. The receding wave swept backward over the village site with sufficient force to remove the greater part of the ice above, as well as the greater portion of the *débris* of the village itself; though scattered ice-blocks could be found several days after the disaster. All this *débris* was swept down the river, together with a number of bodies, which had probably been entangled in the ruins, and carried away in the same movement:

proved by the finding of several corpses as far down as Buckingham village. Of the number of persons who lost their lives in this distressing calamity, not more than half could be accounted for. Of the missing, some have probably been buried in the roughly piled masses of clay or mud along the river bed, with which the channel was choked; while others have been swept down stream, and may be engulfed in the numerous eddies along the river.

The great loss of life in Salette village was, without doubt, caused in large part by falling timbers; the bodies in many cases being badly crushed and disfigured. Had the ice not been present, doubtless the rush of the water would have damaged and possibly destroyed some of the smaller buildings nearer the water; but would not have wrought such wholesale destruction, and probably would have left a larger amount of the clay upon the east bank, much of which must have been kept in check by the overlying ice-mass. The width of the channel at this place, as measured in the survey of the district some years ago, is between 250 and 300 feet. The residents in the houses engulfed on the west side were probably caught in the sliding clays and silts. Several persons were rescued when nearly lifeless from smothering, and exposure to the icy waters.

The unstable nature of the material composing the bluff which fell, can be seen in the close admixture of blue clay and sandy silts in the beds deposited. On the second day after the disaster, portions of the bank were still falling in considerable amount: the upper portion breaking off in masses sufficient to move forward over the debris to a distance of 100 to 150 feet, until stopped by the rough surface of that already fallen. At the time of our visit, it was practically impossible—owing to the unstable condition of the edge of the break—to approach near enough to make an accurate survey of the locality.

The damage on the east side opposite Chalifoux landing, and thence to the road at the old North Star landing, was apparently caused by the water backed up by the clay dam, by which the water in this direction rose to a height of eight to ten feet. Several small bridges were washed away on the little creeks, but the damage to buildings was slight. Above the old landing, apparently no damage was inflicted.

As much interest is now being taken in the phenomena of these landslips, it is considered advisable to refer to other instances of this kind which have occurred in the province of Quebec within comparatively recent times, as illustrating the conditions by which these were brought about. The following extracts taken from a report of the late Dr. Chalmers—of the Geological Survey—on these occurrences along the St. Lawrence, between Three Rivers and Quebec, are, therefore, added:—

“Three landslips of considerable magnitude have been known to occur in this part of the St. Lawrence valley within the last sixty years, and evidences of others, of which there is no account, were observed. The first of these referred to, took place on the bank of Maskinongé river, about nine miles to the south of the granite hills, on April 4, 1840, and was examined and described by Sir W. E. Logan. The area affected was about eighty-four acres, and the chasm is described as oblong in shape, with a narrow funnel-like end towards the river. The total length was about 1,300 yards, while the breadth varied, the widest part equalling 600 yards. When examined by Sir W. E. Logan, the bottom of the widest part of the pit was found to be thirty feet below the level of the surrounding country. The material transported into the valley of the Maskinongé river filled it to a depth of seventy-five feet for a mile and a half. The cause of this landslip, Logan believed to be pressure on an inclined plane, assisted by water, although no subjacent rock-surface was seen.

“The St. Albans landslip occurred on April 27, 1894, on the west bank of the Ste. Anne de la Pérade, about four miles above the village of St. Albans, or seven miles from the Rivière Blanche landslip. Here the deposits (Leda clay and Saxicava sand) slid down bodily into the valley of the river for the space of three miles and a half. The landslip seems to have been in three parts, the first movement being at the northern end, where it was about ten feet deep. This was followed, after some hours, by another which took place immediately to the south of the last; and finally a third descended just below the second, leaving a pit 175 feet deep. The average depth of the whole chasm was not less than 100 feet below the general surface of the ground, and its width about a mile. The mass of material thrown into the valley of the Ste. Anne permanently changed the course of the river.

“The Rivière Blanche landslip was closely similar to that of Maskinongé river described by Logan. As stated above, it took place on the east bank of the Blanche, a tributary of Ste. Anne de la Pérade, at St. Thuribe, about three miles north of St. Casimer village. The banks of the latter river are low and the country flat, forming a part of the St. Lawrence plain, as far up as St. Thuribe, where the valley is crossed by a boulder clay ridge. The superficial formations consist of Saxicava sand and Leda clay, and boulder clay. In the pit where the landslip

occurred, the Leda clay is prolific in marine shells, chiefly *Leda arctica* and *Macoma greenlandica*.

The chasm remaining from this landslide is also irregularly oblong in shape, like that of the Maskinongé valley described by Logan, with a narrow opening at the end towards the Rivière Blanche. At this point the breaking down of the beds began, and through this opening the whole of the flowing material was discharged. The length of the pit, east and west, is about 1,050 yards, extreme width 600 yards, maximum depth about twenty-eight feet; total area, eighty-six acres. The descent of the bottom throughout its whole length is approximately twenty-seven feet or about ten inches to the hundred feet, and the gradient is comparatively uniform from the eastern end to the present bottom of the river.

The movement of clay and sand on such a low gradient, it is obvious, could only have taken place when these materials were in a semi-liquid condition, and from all accounts the landslide resembled the bursting of a reservoir of water. Those who witnessed it, however, informed me that very little water was seen, the flowing mass consisting of a very soft clay or mud. Indications of a movement in the clays were first seen on the evening of May 6, in a small hollow in the bank down which a trickling stream ran, but no attention was paid to it. Up to the hour when the landslide actually commenced, the people who lived on the ground that was swept away crossed it by the highway and went in and out of their houses without any thought of the impending catastrophe. About five o'clock on the morning of May 7, the breaking away of the clay beds began where some slipping had been noticed on the previous evening. Very soon the movement seemed to gather force and work backward through the drier and harder clay in the immediate bank of the river, inside of which it expanded on both sides into the terrace. The softer material flowed out from beneath, while the upper and more coherent clay split off in vertical sheets and columns which were borne away in the sliding surging mass. This continued for upwards of three hours, when the transporting power seemed to have spent itself, and great masses of clay which had become detached from the walls of the chasm stranded in its bottom, and at the time of my examination were seen standing in various positions, some of them resembling cones, pyramids, etc.

The marine deposits in which this landslide occurred are quite arenaceous and silty, especially in the upper part, and no well defined break was seen to exist between the Saxicava sand and Leda clay, the one graduating into the other. Hence the surface waters percolate downwards to a considerable depth during the period of snow melting every season. This excess of water passing into the silty and arenaceous clays and sand must have given the beds greatly increased weight. It is probable also that a zone or layer of softened clay of some thickness was thus pro-

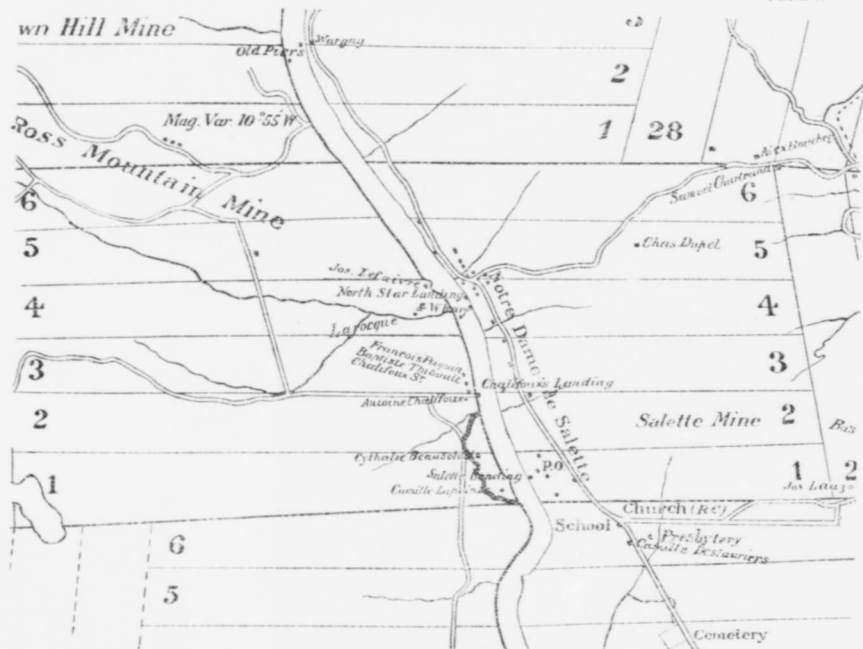
duced beneath the arenaceous strata, and held in by an impermeable hardpan below, and by the hardened clay-banks on the riverward side and on the north where a depression exists, supposed to be the seat of an ancient landslip.

"The cause of the Rivière Blanche and other landslips of this part of the St. Lawrence valley seems to be:—

"1. The silty and arenaceous character of the Leda clay, rendering it capable of absorbing and retaining a large amount of water; and,—

"2. The increased precipitation during the seasons when these landslips occurred, which saturated the deposits and gave them greater weight than usual. These conditions doubtless produced unstable equilibrium of the beds, resulting in displacement and a flow of the semi-liquid portion. The more coherent clays, breaking down as described, and mixing with the soft material, produced a tumultuous mass of mud, clay and sand, which descended into the nearest valley."

The extracts quoted above, appear to cover very thoroughly the principal points involved in the occurrence of landslips, at least in the province of Quebec. It would appear also, that a recurrence of similar conditions will at times be attended with similar results. It does not appear to be possible to adopt any special methods to prevent these disasters. The simplest method to prevent loss of life seems to be, to prevent the placing of buildings near the front of bluffs, or shores where the unstable clay deposits are liable to be affected by the conditions already indicated. Fortunately, these catastrophes are comparatively rare, and with proper attention to location of houses, or farm buildings, much loss of life can be prevented. The loss of life in connection with the recent calamity at Sallette is attributable for the most part to conditions which are not likely to be repeated, if proper precautions are taken as regards the location of residences; while the high agricultural value of many of these clay flats is such that their abandonment would be a great hindrance to the general development of the country.



Map of area showing position of landslide at Notre-Dame de la Salette. The area between the river and the irregular heavy black line opposite the valley plunged into and across the river.

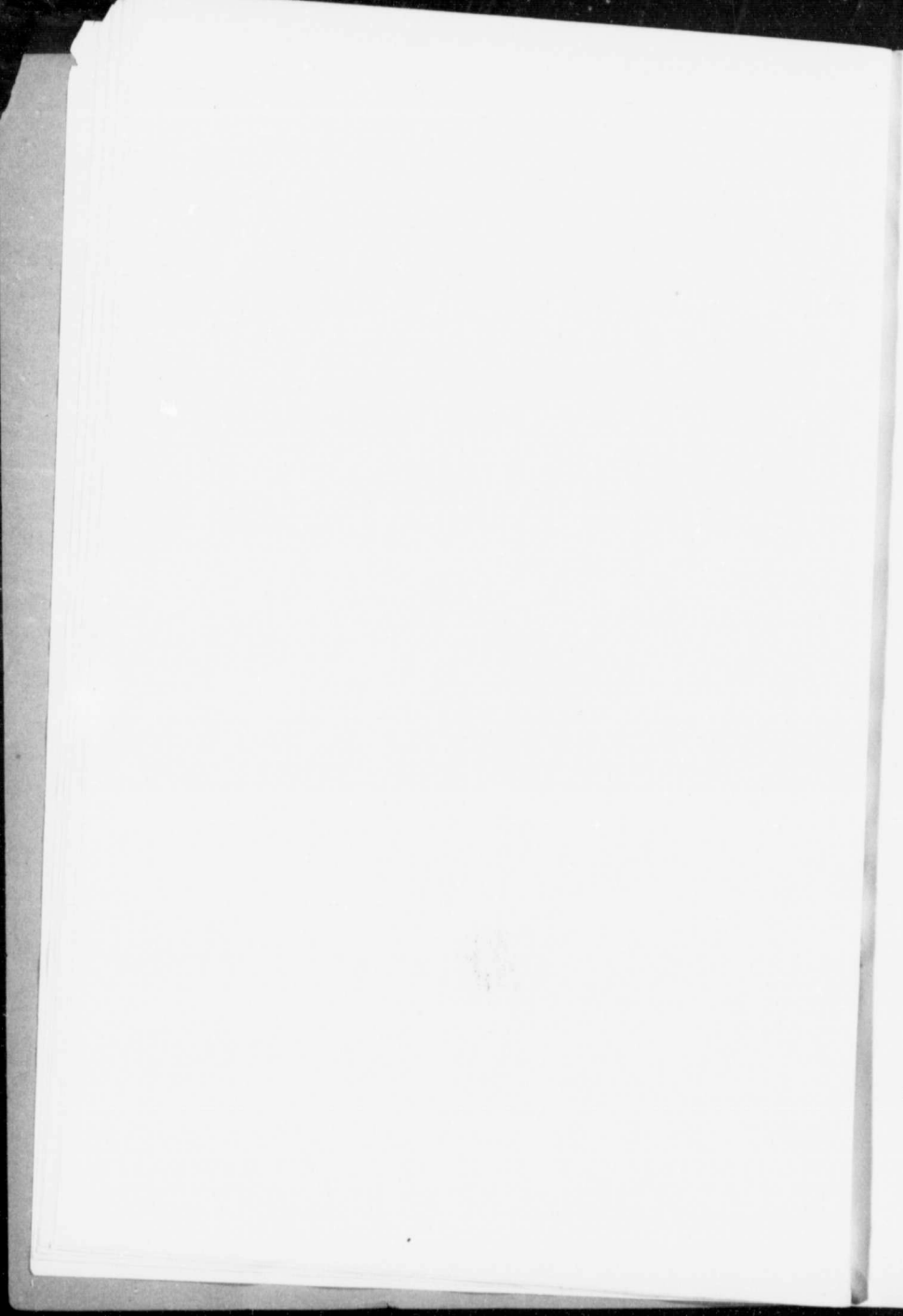


PLATE II.

II



Looking north over zone of destruction (a).



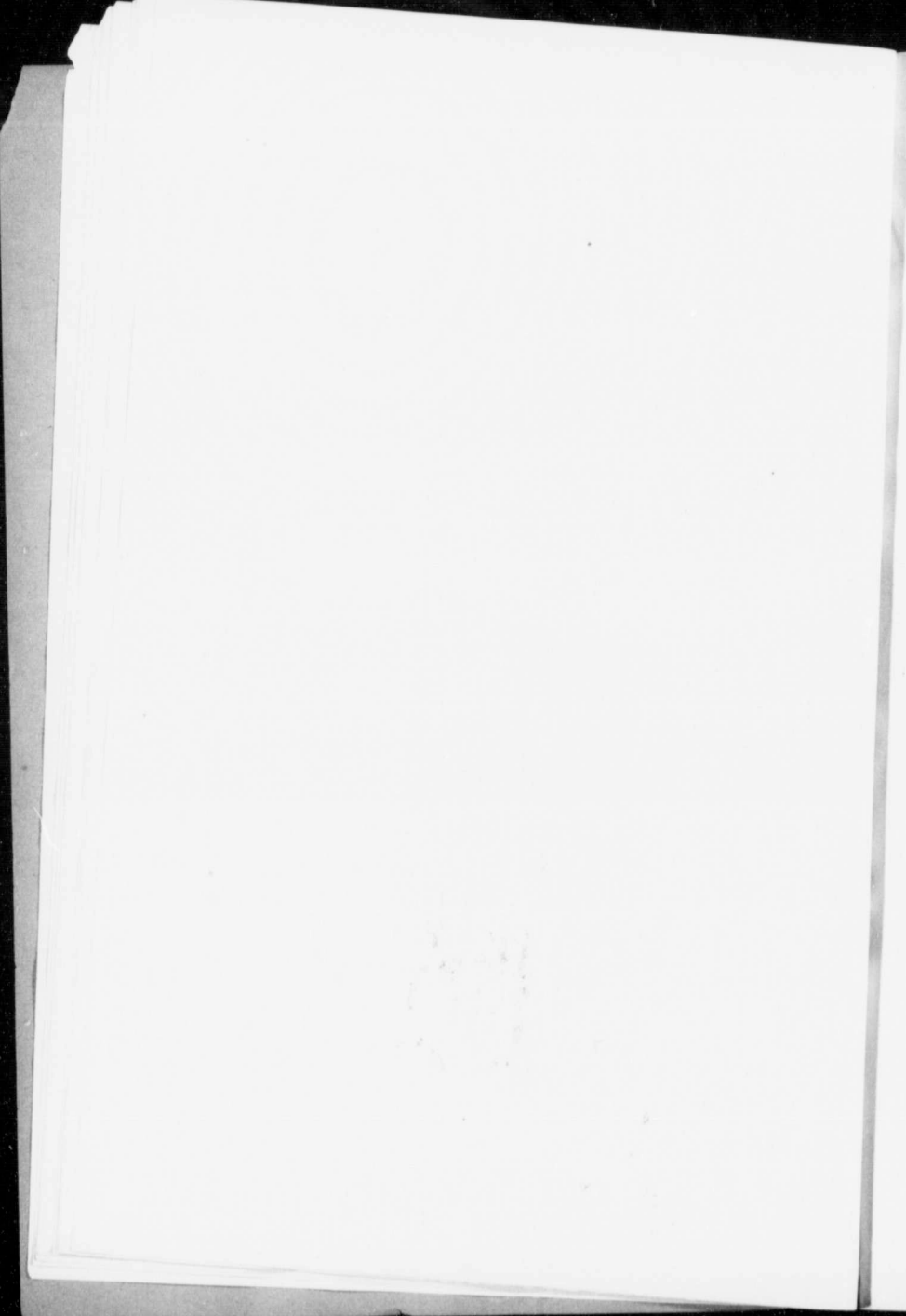


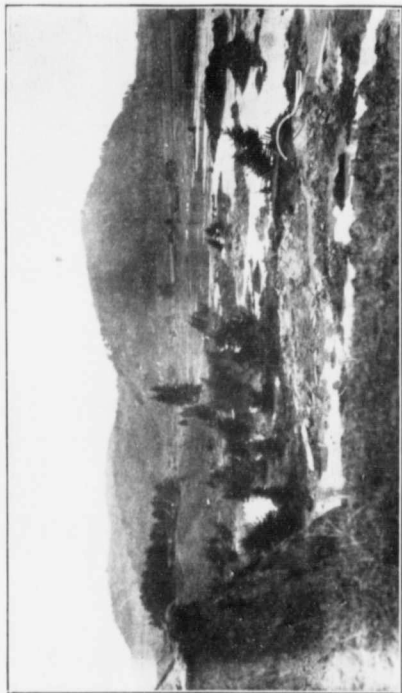
Looking north over zone of destruction (b).





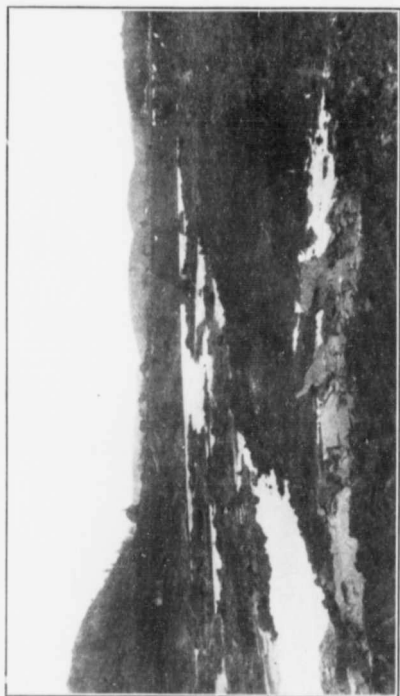
South end of landslide showing fractures from which the mass broke away.





North end of landslide.





Centre of lamellicide.





Channel looking down stream from east shore.
The mass broke away from the clearly defined face of the higher cliffs shown on the right hand.