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BY

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Some Observations at le Coteau Landslide, Gatineau, Quebec

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In April 1971, landslide activity developed in a 100-ft (30.5-m) high clay slope in a housing development. This note describes the landslide and discusses the pore-water pressure measurements made at the site.

En avril 1971, un glissement de terrain a eu lieu dans une pente d'argile d'une hauteur de 100 pi. (30.5 m) dans un projet de logement. La présente note décrit le glissement de terrain et discute des mesures de la pression de l'eau interstitielle qui ont été faites sur les lieux.

Introduction

The following notes record observations made by the Division of Building Research during landslide activity which occurred along Le Coteau St., Gatineau, in April 1971. The notes are confined to a description of events, the tabulation of piezometer records obtained from the site, and a brief discussion of the significance of the observations in relation to the regional slope stability problem. It is understood that borings and detailed stability analyses related to the specific landslide event are being undertaken by the developer and possibly by the Quebec Department of Natural Resources.

Sequence of Events

In late 1970, a developer began construction of several row houses on the slope of a steep hill north of Hillside Road in the town of Gatineau. Five row house units were under construction along Le Coteau St. which is located in part on a side hill cut along the face of a 100-ft (30.5-m) high clay terrace. Considerable landscaping was being done in conjunction with the housing development. The eastern end of Le Coteau St. was left in an unfinished state with a very steep cut slope during the winter of 1970–1971.

On Monday, 5 April 1971, a small landslide occurred in this unfinished slope at the eastern end of Le Coteau St. as shown in Fig. 1. It involved a few thousand cubic yards of clay and destroyed a construction shack. This occurrence indicated a potentially dangerous situation for the residents of the immediate area and several families were advised to evacuate their homes temporarily on 7 April. During the night of 7 April a second landslide occurred west of the first occurrence, destroying a partially completed row house. Figure 2 shows this slide. On 8 April, four vibrating wire piezometers were installed at locations shown on Fig. 1 in an attempt to obtain information on the changes in pore water pressure in the slope at the point of critical equilibrium. The readings would also assist officials in deciding when the dangerous period had passed for the slopes.

During the afternoon of 8 April, the temperature rose above freezing so that snow melting occurred. About 3 p.m. a third small landslide occurred, partially blocking Le Coteau St. Immediately prior to this landslide, a small stream of water from the melting snow was observed to disappear into a fissure near the crest of the slope. DBR personnel installing piezometers were able to observe the progress of this landslide.

The slopes remained stable until 12 April, when a significant rainfall began. The fourth slide occurred about 10:30 a.m. and was the largest of the series. It occurred at the same location as the first slide and pushed debris from there almost to the house situated at No. 209 Hillside. Rain continued during the night of 12 April. About midnight, the fifth and final slide of the series occurred, immediately west of the first occurrence, covering Le Coteau St. with debris. The locations of all the slides are shown on Fig. 1; Fig. 3 is an aerial view. Figure 4 shows four of the five occurrences.

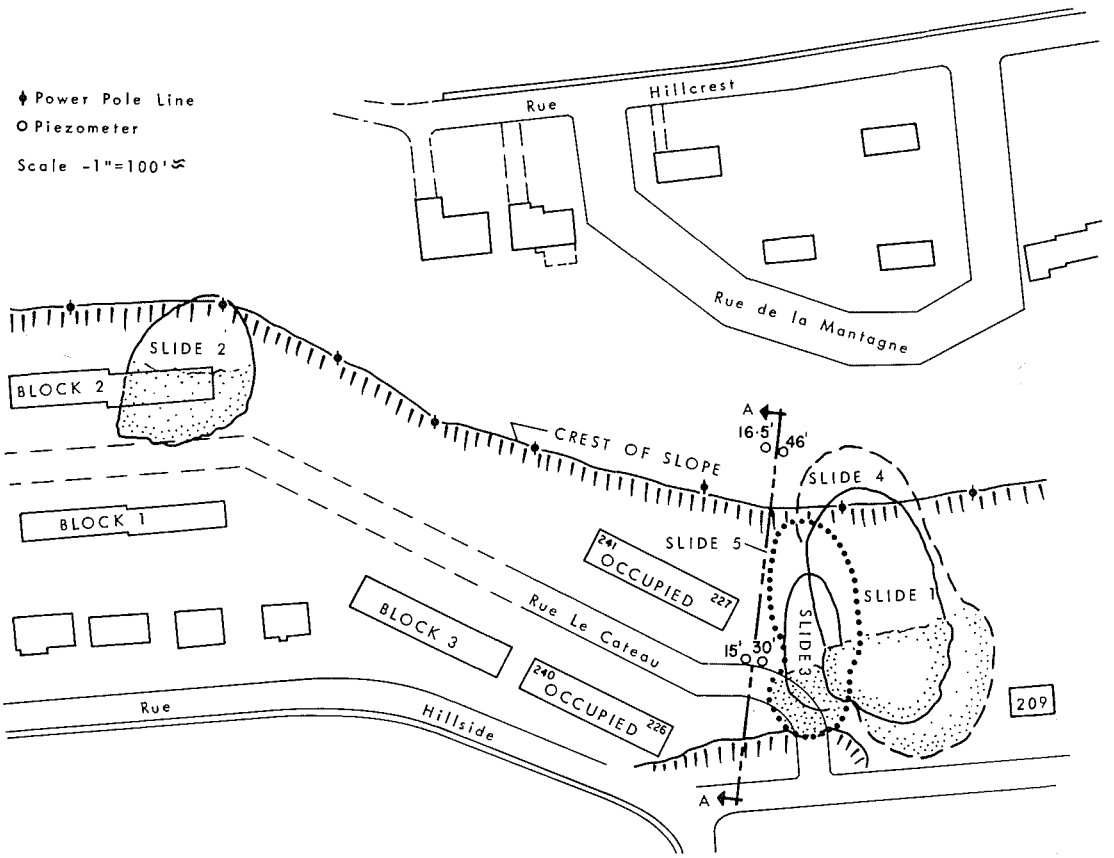

FIG. 1. Sketch plan of Le Coteau landslide.

Piezometer Installation

Two of the four vibrating wire piezometers installed on 8 April 1971 were located on the north side (curb line) of Le Coteau St. near the foot of the landslide activity. The other two were located behind the crest of the slope. It was hoped that sufficient information would be obtained with the piezometers to construct a flow net from which conclusions could be drawn concerning the groundwater conditions in the hillside.

All piezometers were Geonor M-600 no-volume change vibrating wire instruments with a range of 0–2.0 kg/cm^2. The tip consists of a small porous bronze filter over a small cavity that is filled with water acting on a sensitive membrane which in turn is attached to the vibrating wire strain gauge. Readings were taken with a Geonor P-500 Digital Frequency Meter that measures frequency to the nearest 1 c.p.s. Each piezometer was calibrated by the manufacturer.

Readings began immediately after installation and were continued on a more or less daily basis for the month of April. They were taken initially using a portable generator set. Some difficulties were encountered with the stability of this power source and later readings were taken with a 6-V battery powering a D.C.–A.C. converter. The piezometer readings, which have been converted to piezometer elevations, are presented in Fig. 5. Figure 6 is an approximate profile of the slope indicating the relative vertical positions of the piezometers and the groundwater levels.

Figure 5 shows that the piezometric levels were relatively stable, changing slowly with weather conditions. Rainfall records over the period of the readings are also presented

FIG. 2. Slide No. 2 and wreckage of partially completed row house.

FIG. 3. Aerial view of landslide site. *A*. Slides 1, 3, 4, and 5. *B*. Le Coteau St. *C*. Slide 2.

FIG. 4. View of Slides 1, 3, 4 and 5.

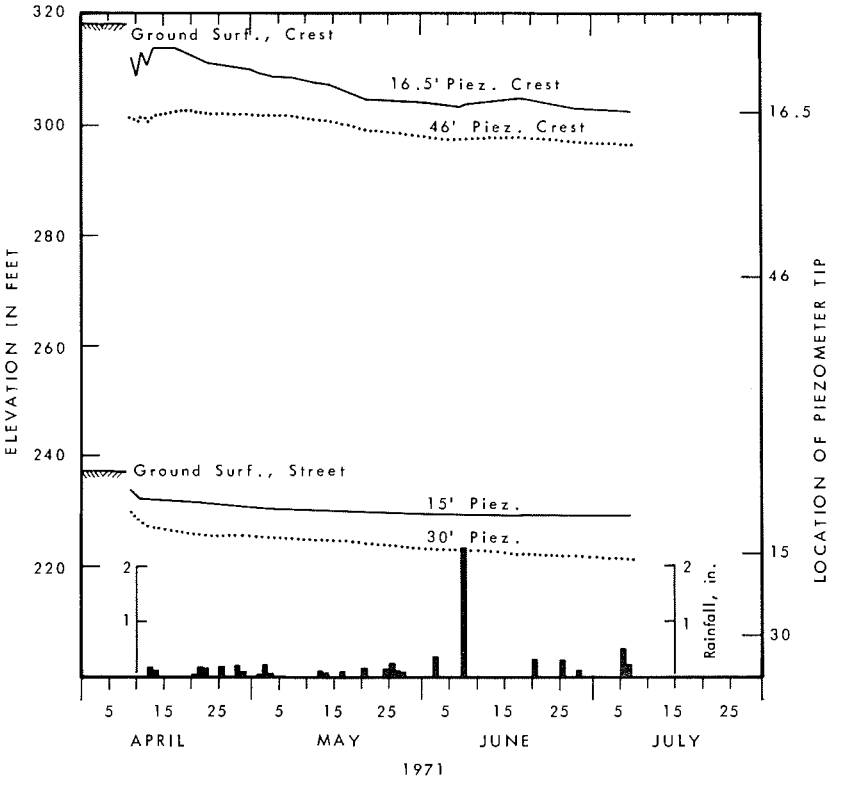

FIG. 5. Piezometer and rainfall records for Le Coteau landslide, Gatineau.

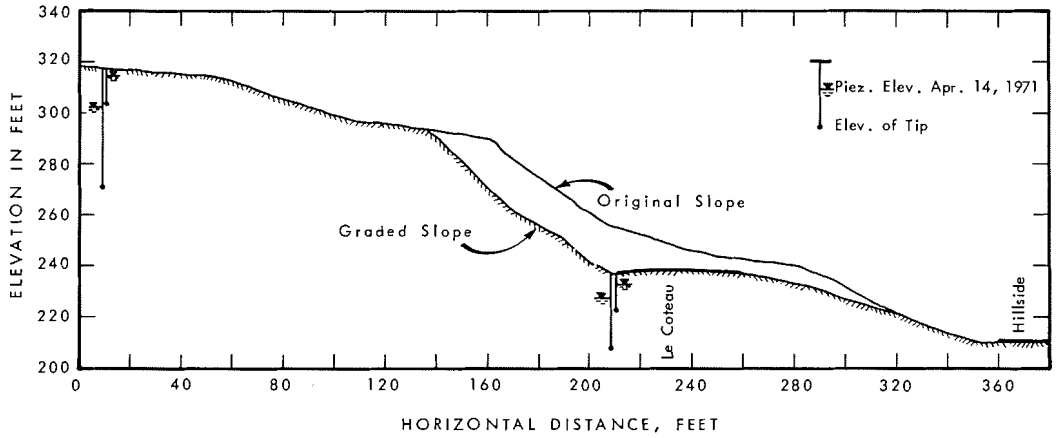

FIG. 6. Slope profile A-A through piezometers.

in Fig. 5. Daily temperatures for the critical period in April are presented in Table 1.

Discussion

Several features of these landslides can be compared to previous studies by the Division of Building Research on clay slopes in the Ottawa area (Eden and Jarrett 1971; Eden and Mitchell 1970; Jarrett 1970; Ladanyi 1970; Mitchell 1970; Mitchell and Eden 1972; Paul 1971; Sangrey and Paul 1971).

(1) The landslide activity appeared to be confined to the fissured surface layers of the clay. All materials involved in the landslide appeared to have a granular or nugget-like structure. Landslide activity was definitely associated with a ready supply of water, either from melting snow or from rainfall.

TABLE 1. Maximum and minimum temperatures April 1971 recorded at NRC Ottawa (°F)

Date	Maximum	Minimum
April 1	39	22
April 2	41	32
April 3	41	27
April 4	34	22
April 5	36	20
April 6	40	17
April 7	43	20
April 8	36	16
April 9	40	20
April 10	42	25
April 11	51	25
April 12	50	29
April 13	47	37
April 14	36	28
April 15	43	24
April 16	49	29
April 17	40	28

(2) The piezometers did not indicate large changes in pore-water pressure at depth. Indeed, the records indicate that, in general, the groundwater pressure was stable and responded rather slowly to weather conditions. The 2-in.-plus rainfall that occurred on 7 June did not have any immediate effect on the piezometer levels. Surface water flowing into fissures and tension cracks seems to have had a greater immediate influence. This direct supply of water to the shear zone would enable the clay to dilate more easily during shear.

(3) Numerous tension cracks and one instance of bulge of the toe of the slope were observed. Figure 7 shows the tension crack that preceded the fourth landslide. Figure 8 indicates the bulging that occurred at the toe of a steeply graded slope immediately behind row house 227 at 241 Le Coteau St., which was not affected. These movements indicate active shear in the slope which did not result in full failure.

(4) Reliable eyewitness accounts are available for two of the series of landslides. In both cases, the velocity of the landslide was rather slow. It would have been quite possible for a man to walk safely out of the path of a landslide.

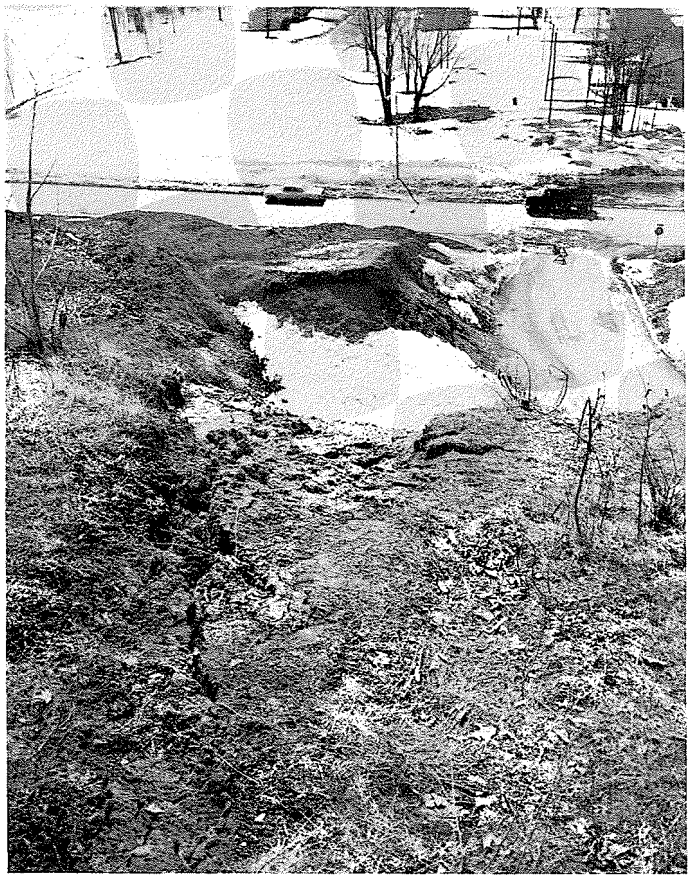

FIG. 7. Tension crack near crest preceding 4th landslide.

The above observations are in agreement with some of the conclusions reached previously about clay slopes in the Ottawa area in that:

(1) failure takes place in fissured material with dilatancy of the clay in the shear zone,

(2) a supply of water directly to the shear zone controls the rate of shear, and

(3) considerable movement can take place prior to the actual failure.

The landslide in Gatineau took place after a winter of record snowfall. The snow melt period was very gradual causing maximum uptake of water by the soil and high groundwater conditions. Had the snow melt been very rapid or a heavy rain occurred, the ground movements would probably have been more rapid and more serious.

Acknowledgments

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FIG. 8. Bulge at toe of slope behind row house 227 at 241 Le Coteau.

EDEN, W. J., and JARRETT, P. M. 1971. Landslide at Orleans, Ontario. Tech. Paper 321, Division of Building Research, National Research Council.

EDEN, W. J., and MITCHELL, R. J. 1970. The mechanics of landslides in Leda clay. Can. Geotech. J. 7(3), pp. 285–296.

JARRETT, P. M. 1970. The mechanics of landslides in Leda clay: Discussion. Can. Geotech. J. 7(4), pp. 504–505.

LADANYI, B. 1970. The mechanics of landslides in Leda clay: Discussion. Can. Geotech. J. 7(4), pp. 506–507.

MITCHELL, R. J. 1970. Landslides at Breckenridge, Pineview Golf Club and Rockcliffe. Tech. Paper 322, Division of Building Research, National Research Council.

MITCHELL, R. J., and EDEN, W. J. 1972. Measurements of slope displacements. Can. J. Earth Sciences, 9, pp. 1001–1013.

PAUL, M. J. 1971. The mechanics of landslides in Leda clay: Discussion. Can. Geotech. J. 8(1), pp. 143–148.

SANGREY, D. A., and PAUL, M. J. 1971. A regional study of landslides near Ottawa. Can. Geotech. J. 8(2), pp. 315–335.