CAUSE AND PREVENTION OF POTENTIAL ROCK-FALLS NORTH OF SAVANNA, ILLINOIS*

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An unusually interesting problem in engineering geology is involved in a situation that occurs two miles north of Savanna, in the northwest part of Illinois. At this locality Mississippi River flows almost against the east wall of its valley (fig. 1). The valley-wall itself is a precipitous bluff approximately 250 feet high. A

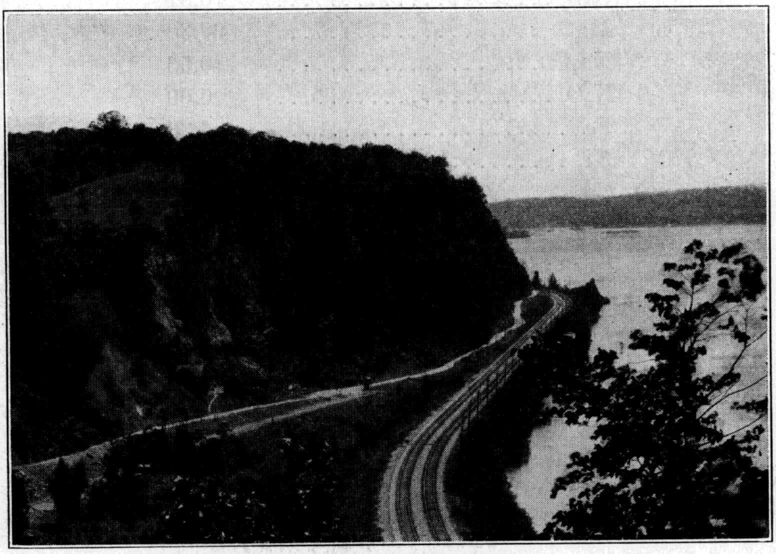

FIG. 1. View of bluff two miles north of Savanna, showing relations of the river, the railroad, and the highway. (*Photo by Illinois State Highway Division.*)

public highway follows the foot of the bluff, and the main northwest line of the Chicago, Burlington, and Quincy railroad follows the bank of the river near the bluff.

At the precise locality under discussion (fig. 2) the highway originally lay between the railroad and the river, but some years ago the railroad company realigned its roadway and prepared a new public road between the railroad and a projecting nose of the bluff. In order to make room for the new public road it was

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necessary to remove the toe of the talus slope at the foot of the bluff. This caused the talus to slide down from time to time, so that for about two years the railroad company had a steam shovel on hand to keep the road clear. A wider roadway with more clearance at this place was desired for the new concrete highway (State Highway No. 80) that is being constructed along the river, so the rest of the talus slope was removed (fig. 2) and was dumped into the river on the west side of the railroad. Preparations were made to blast down an intermediate shelf of rock along the south part of the nose.

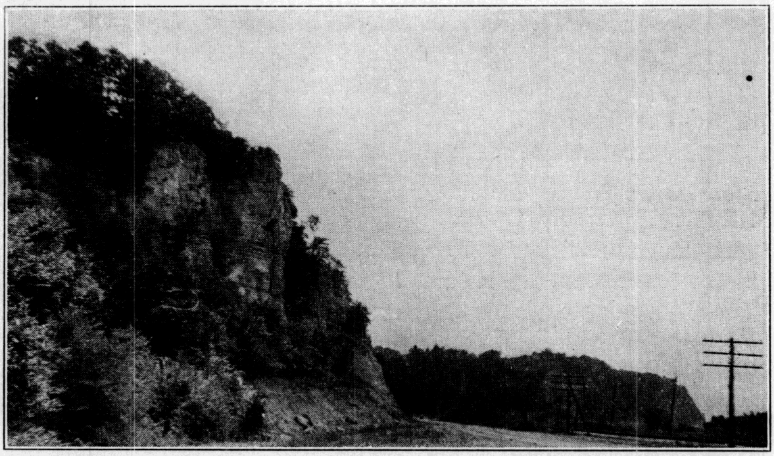

FIG. 2. Near view of bluff two miles north of Savanna, where conditions favor rock-falls. (*Photo by O. F. Goeke.*)

While this work was in progress, some small rock-falls occurred at the north part of the nose, where the talus had been completely removed (fig. 3). These falls alarmed the resident highway engineer, who informed the district engineer, who in turn appealed to the Illinois State Geological Survey for advice. Accordingly an examination was made, about a year ago.

This examination revealed that most of the rock exposed in the bluff consists of Silurian limestone and dolomite (fig. 4), of which the upper part belongs in the Niagaran series and the lower 30-40 feet belongs in the Alexandrian series. About 10 feet of Maquoketa (Ordovician) shale was exposed beneath the limestone at the base of the bluff where the talus had been removed. Seeps and springs occur at and just above the contact between the shale and limestone. The limestone is covered by a mantle of loess as much as 40 feet thick, approximately. Sinkholes occur on top of the bluff and extend through the loess into the limestone.

The rainfall that is precipitated on the top of the bluff soaks down through the loess and gathers in the sinkholes, whence it continues its way downward through solution channels and crevices in the limestone until it encounters the relatively impervious shale.

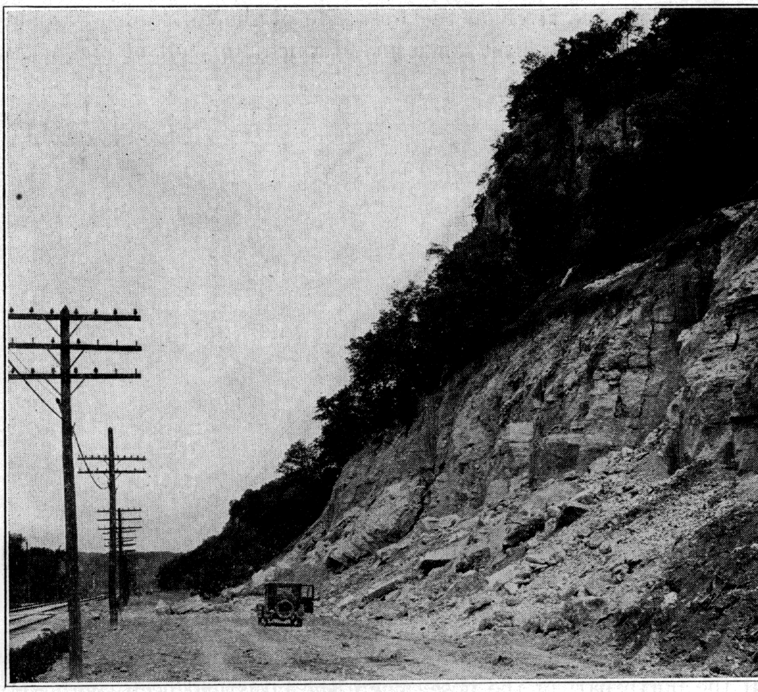

FIG. 3. Close view of the same bluff, showing rock exposed by clearing away talus and also showing small rock-falls. (*Photo by Illinois State Highway Division.*)

Thence it moves laterally along the top of the shale to issue as seeps or springs wherever the contact between the shale and the limestone may be exposed. This water tends to soften the shale and to lubricate its contact with the limestone. When the shale is softened it tends to yield under the weight of the overlying rock. The removal of the talus allows the shale to squeeze outward, which in turn allows a mass of the limestone along the face to settle, to break loose, and to fall towards the road. In small rock-falls (fig. 5) there would be a rotatory movement outward at the base and downward along the fracture plane, but in large falls the top of the rock would gain momentum more rapidly than the base and would topple outward soon after the movement started.

In view of these conditions it was recommended that such small falls as had already occurred should not be removed, but that they should be supplemented by other masses of rock, either blasted from the face or recovered from the dump. These masses would serve as an artificial talus (fig. 3) that would prevent the shale from yielding laterally and thus would prevent rockfalls. The insertion of well-points along the contact between the shale and limestone in order to drain away the seepage before it emerged and the sealing of the surface sink-holes were also considered, but they were not deemed to be feasible or wholly effective schemes.

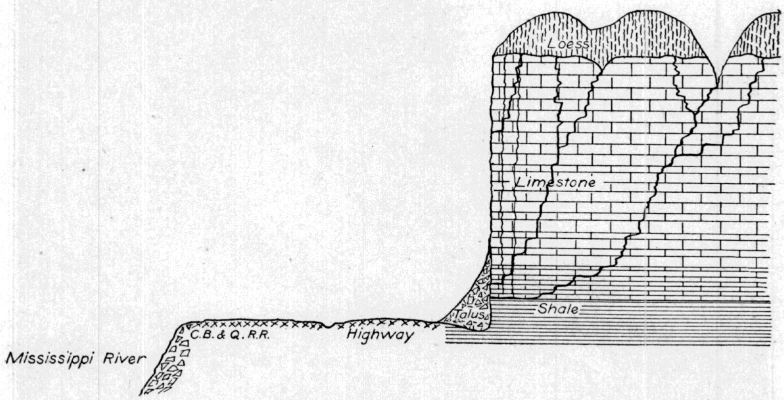

FIG. 4. Diagrammatic cross-section sketch showing geological conditions at highway cut two miles north of Savanna.

An interesting complication in the situation arose shortly after the examination was made. Rain was falling during the day of the examination and continued during the following night. About two o'clock of the next afternoon a large mass of the rock-shelf at the south end of the bluff fell across the road and railroad. The contractor's engineer, who was present at the time, reported that the whole mass moved bodily outward a few feet, settled downward, and then the upper part fell forward. Fortunately, the two rigs that were drilling holes for blasing were sitting one on either side of the mass that fell, but one of them was almost marooned and it was hurriedly withdrawn to safety. More fortunately, it caused no disaster on the railroad, although the fall occurred just in time to block the fastest passenger train on the railroad, the Oriental Limited, for two hours, and the superintendent of the railroad was on the train! As a result of the fall and its consequences, another conference was held at which not only the district engineers but also the state highway engineers and the acting chief engineer of the railroad company were present. The situation was reviewed and the recommendations repeated. The engineers concurred in the recommendations and the artificial talus was prepared as soon as practicable. Since then no rock-falls have been reported.

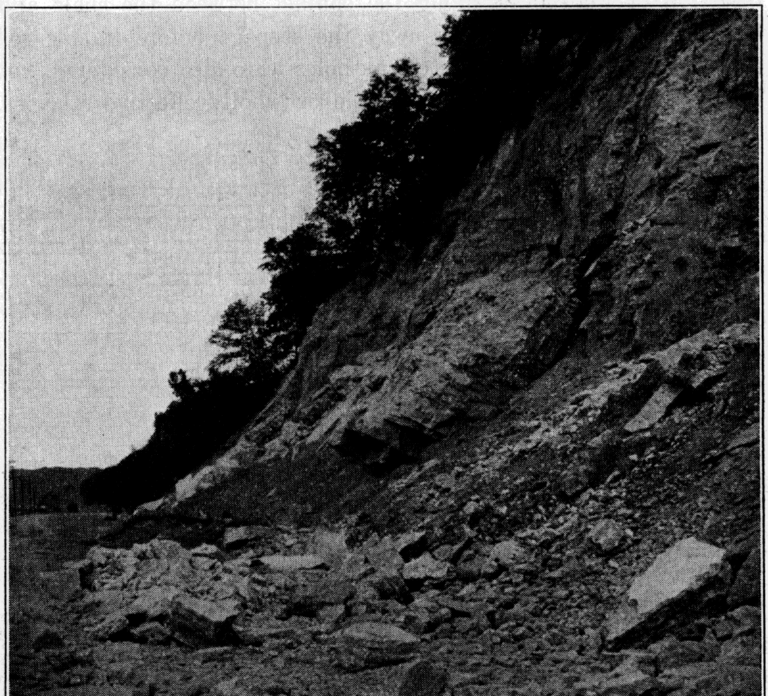

FIG. 5. Close view of small rock-falls and talus at foot of bluff. (*Photo by Illinois State Highway Division.*)

This situation aptly exemplifies the intimate relation between geology and engineering. It shows how important it is for engineers to know and to appreciate ordinary geological relations. It also shows what disastrous results may follow ignorance or neglect of these relations, and what simple measures may be adopted to prevent such avoidable consequences.