## Weathering pyrite and Bacteria bug the Bell



A black pyritiferous, fissile shale rock some 500 million years old, called the Billings Formation, underlies much of the eastern part of the City of Ottawa. To the west is the Gloucester Fault, a major dislocation in the bedrock structure which trends northwest by southeast, its presence reflected by numerous minor faults.

At the corner of Albert and O'Connor Streets, stands a structure founded on Billings Shale — the Bell Canada building — originally constructed in 1929. A three-storey extension, which passes over a minor fault, was added 10 years ago.

Could such a fault play some role in the nearly four inches of heave the basement floor of the extension has experienced since construction? Could the level of the ground-water table play some part? Or could weathering of the shale together with certain other favorable conditions be responsible?

In 1967, Bell initiated precise level surveys. Since that time, the position of maximum displacement in one area shows heave of 2.04 inches, or 0.07 inch per month. Total heave since construction is 3.72 inches. In another area, the total heave is 2.16 inches and the heave rate during the survey period was 0.02 inch per month. These two heaved locations cover a floor area of some 2,400 square feet. This space is used for generators, batteries and switching units which power telephone service in Ottawa. Heaving of the floor necessitated continual realignment of equipment and in addition, a non-loadbearing partition wall had to be freed from the ceiling to avoid damage to the first floor.

This unique and serious problem now has been solved by the National Research Council of Canada and results of the research have been made available to the Canadian construction industry. This information will permit similar problems elsewhere in Canada to be resolved, and will also enable the industry to take action during construction to prevent heaving if this is necessary.

When Bell asked NRC to look into the problem in 1968 there seemed to be no apparent explanation for the heave. Since then several other buildings located on shale in the Ottawa area have been found to have problems of heave and are under investigation.

"We didn't know what it was at first either," says W. J. Eden of the Geotechnical Section of NRC's Division of Building Research. "Our first clue came when an excavation was dug for the Vanguard building next door to the Bell on Slater and O'Connor Streets. Heave caused diagonal crack from top to bottom on this non-loadbearing partition wall which had to be freed from the ceiling to avoid damage to the floor above.

le soulèvement a provoqué une fissuration diagonale de cette cloison non travaillante qu'il a fallu dégager du plafond pour éviter que le plancher de l'étage immédiatement supérieur ne soit endommagé.

In the shale bedrock, we noticed a yellow material which was identified as jarosite, an ocher-yellow or brown mineral. A search of the literature seemed to indicate a biological origin."

The mining industry in the United States had become aware of a similar problem in the 1950s when rapid oxidation of sulphide minerals in coal mines and copper operations was traced to the presence of bacteria. In the early 1960s, operators of mines in the Elliot Lake, Ontario, uranium field observed that mine waters had become acid and contained appreciable concentrations of uranium and ferric iron in solution. The high ferric to ferrous ratio suggested an oxidation reaction more intense than simple air oxidation. Studies showed bacterial activity here as well.

After consultation with Dr. K. C. Ivarson of the Soil Research Institute, Canada Department of Agriculture, who had been involved in the Elliot Lake study, Mr. Eden and his colleagues thought that bacterial activity also might be the cause of the Bell's problem. An exploration pit was dug under the Bell near the point of maximum heave and although the original bedrock was sound black shale, the top 30 inches of the shale was now a completely shattered mass which contained