



# KUWANO LAB.



## [Prevention of Ground Cave-in]

International Center for Urban Safety Engineering

<http://geo.iis.u-tokyo.ac.jp>

Geotechnical and Geo-environmental Engineering

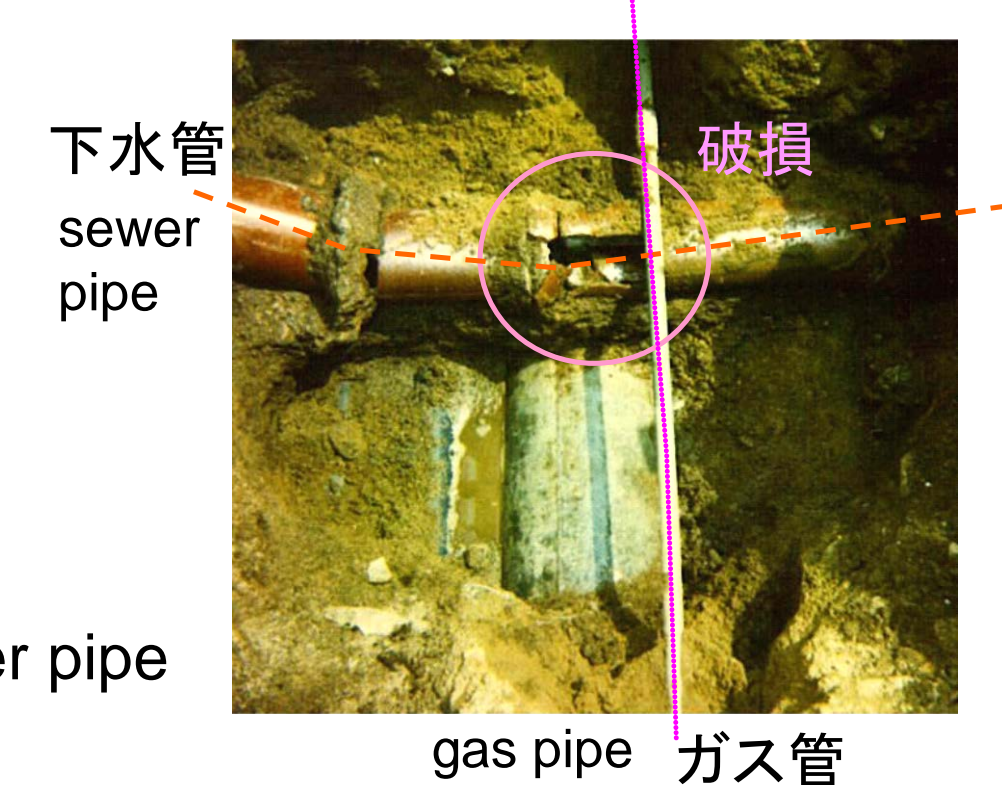
Dept. of Civil Engineering

### Hidden Cavity in the Ground Causing Ground Cave-in

Local subsides or cave-in's of the ground often occur in urban area. The complicated underground situation as well as the necessity of urgent restoration do not usually allow full investigation of the real cause. The detailed mechanism of the phenomenon has not been, therefore, well understood. Cave-in is usually initiated by the formation of cavity in the ground due to soil loss. When the location of the cavity is deep in the ground, the detection of the cavity is not easy. Then it is possible that the hidden cavity expands for a long time to eventually cause sudden large-scale collapse. In this study, characteristics of formation/expansion of cavity and surrounding ground loosening are investigated, aiming at effectively indicating dangerous pattern of cavity and loosening.



Road cave-in due to corrosion of sewer pipe

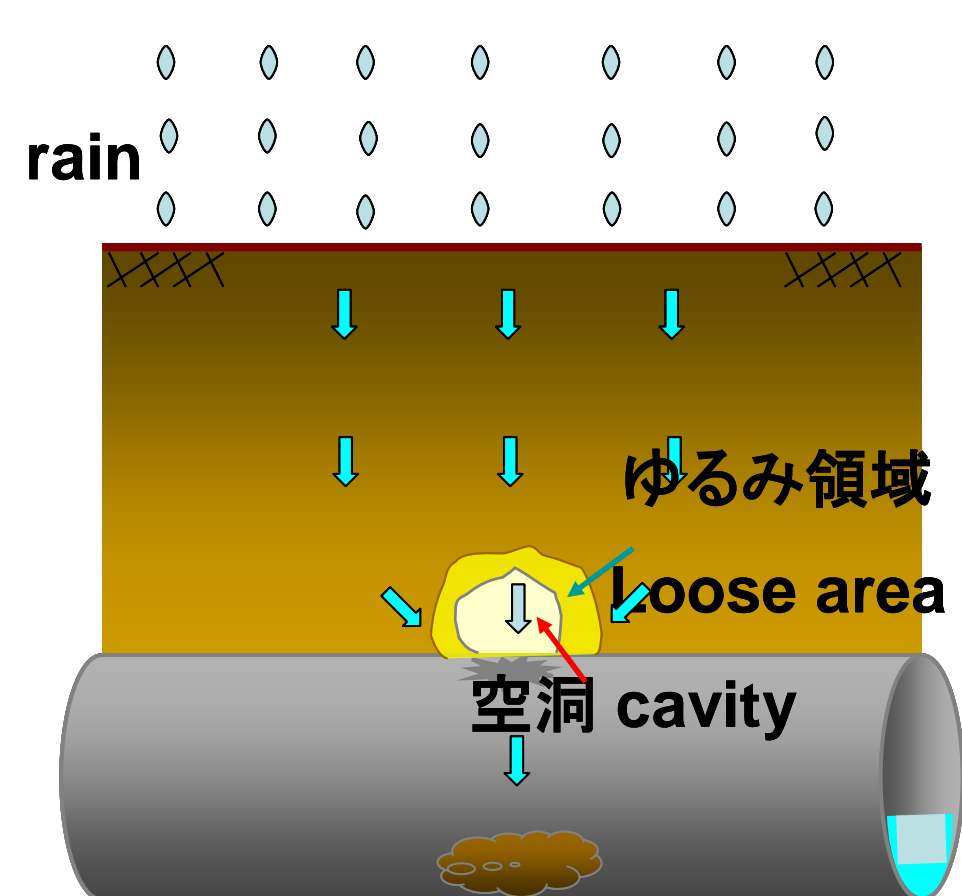


Damaged sewer pipe

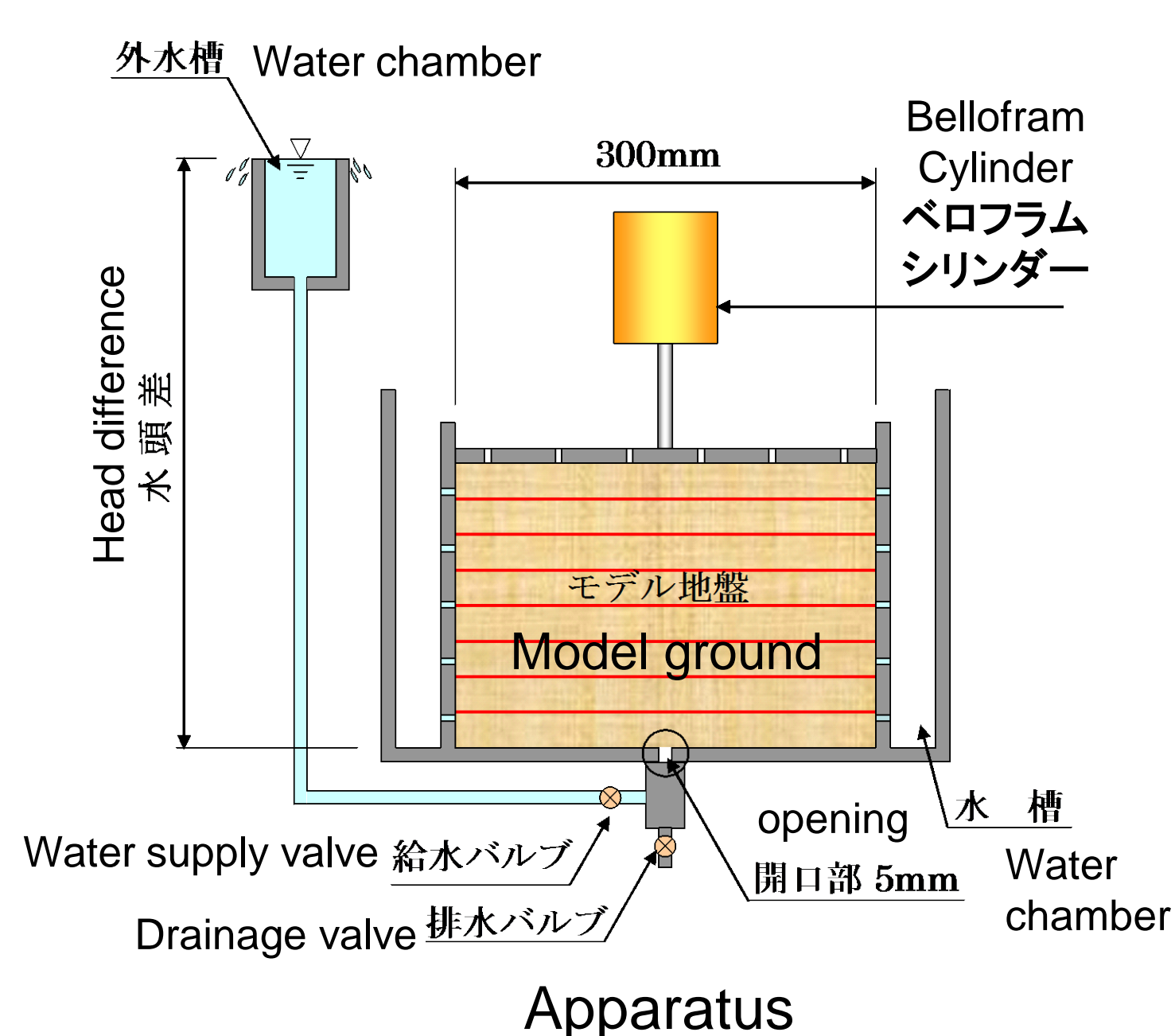
gas pipe ガス管

### Shallow Underground Cavity Due to Defects of Buried Pipe

#### Model test simulating ground cavity formation



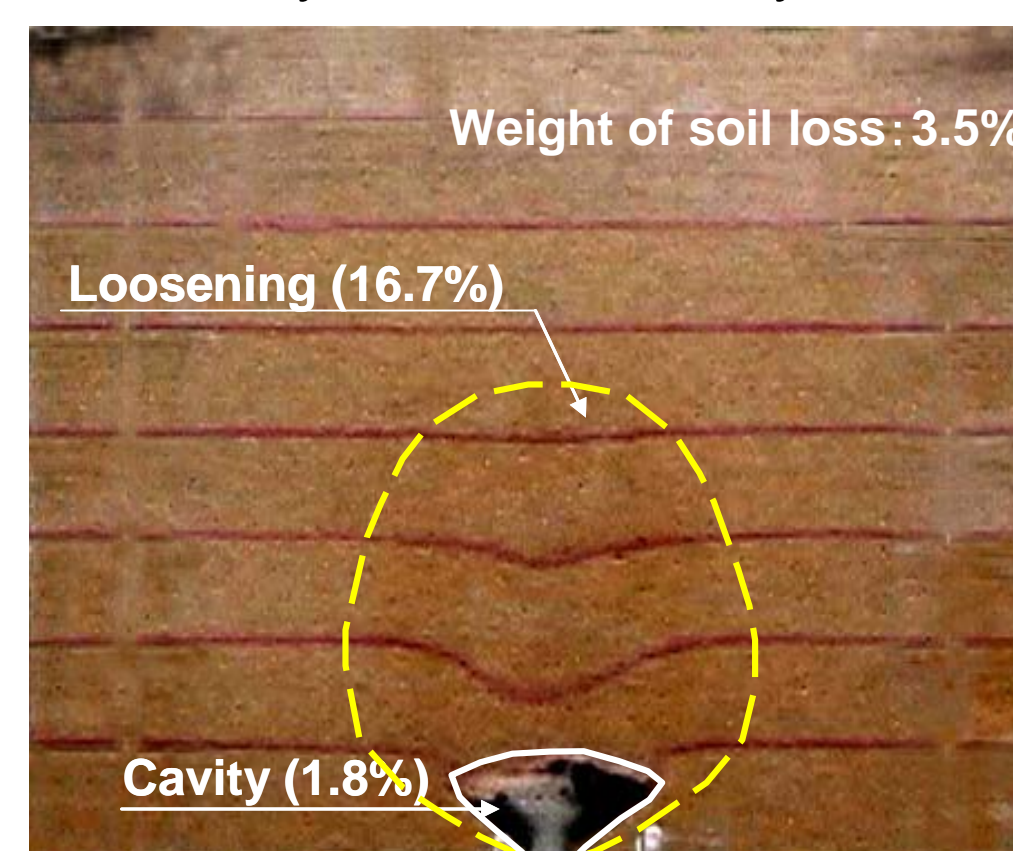
Subsurface erosion above the defects of buried pipe



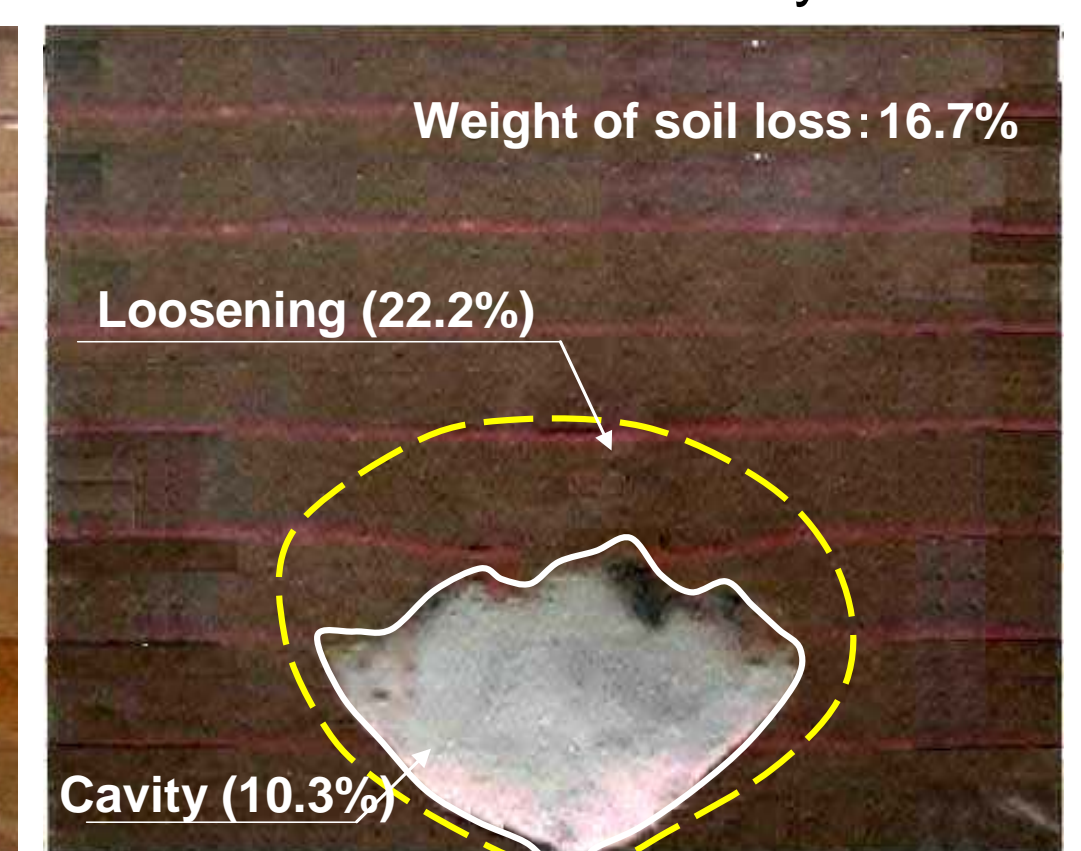
#### Evaluation of Loosening around cavity

Toyoura sand (3 cycle)

Sand with fines (13 cycle)



Small cavity: Large area of loosening  
Degree of loosening: 15%

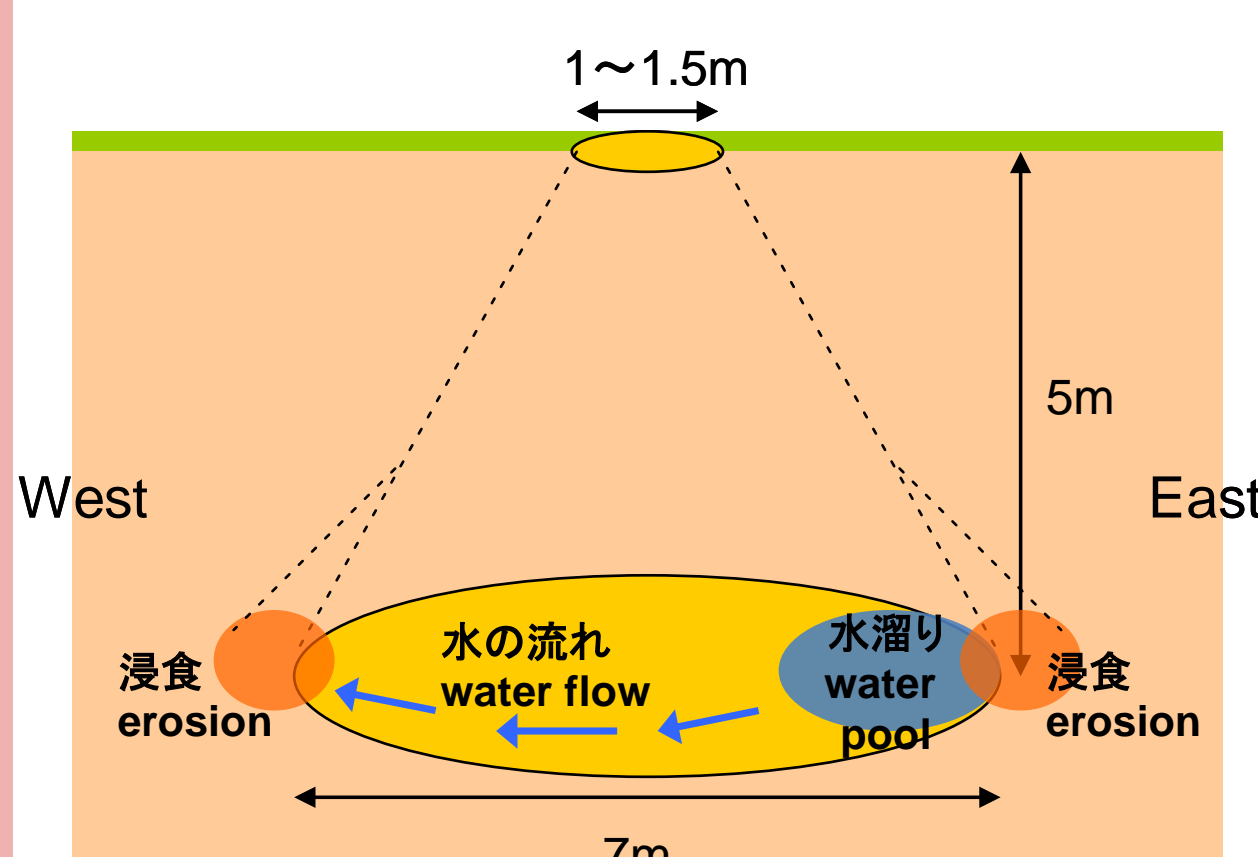


Large cavity: Small area of loosening  
Degree of loosening: 50%

### Large Scale Cave-in Caused by Deep Underground Cavity

It is not easy to search for deep underground cavities. They sometimes grow silently until they eventually cause large scale cave-in.

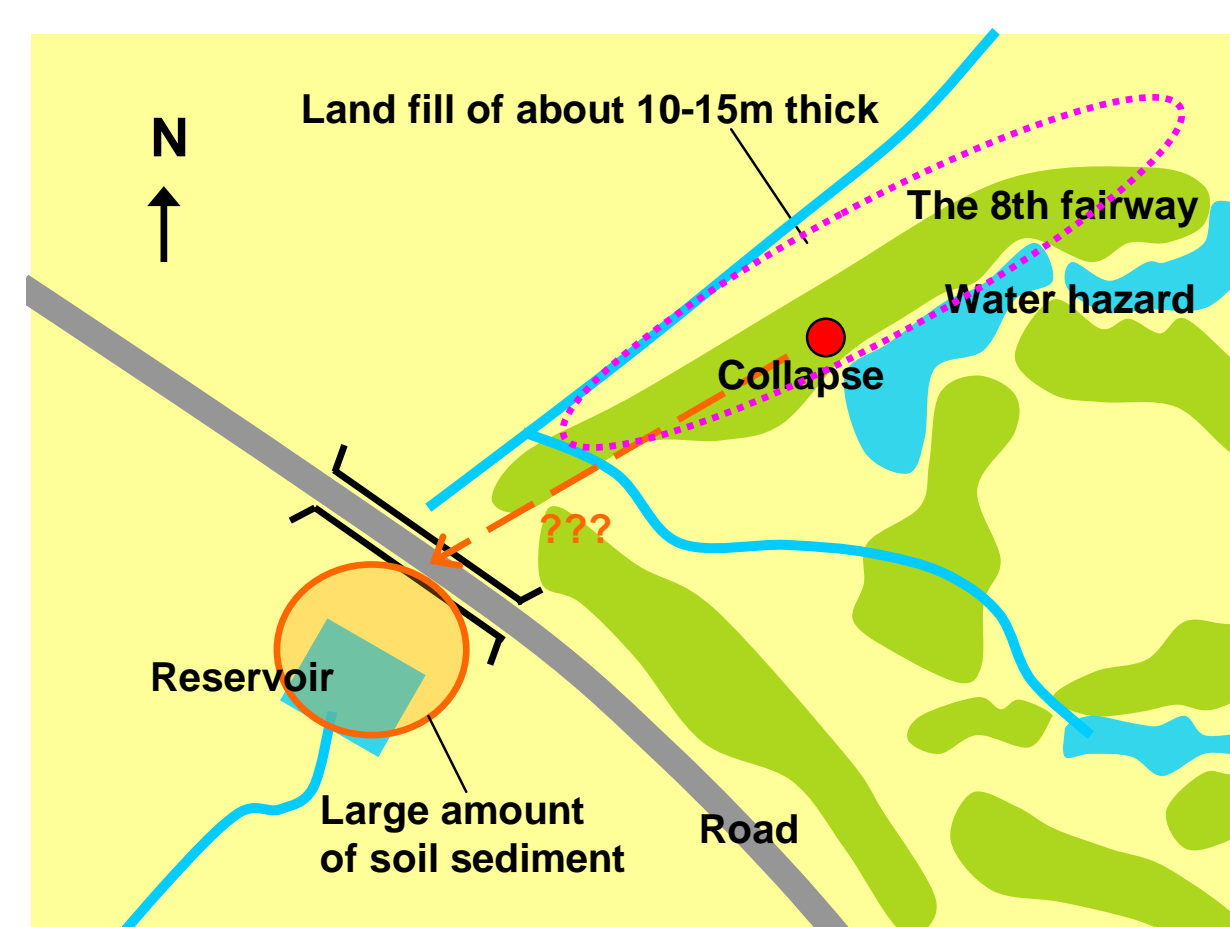
#### Cave-in accident in Hokkaido Abira-town golf course (2009 April)



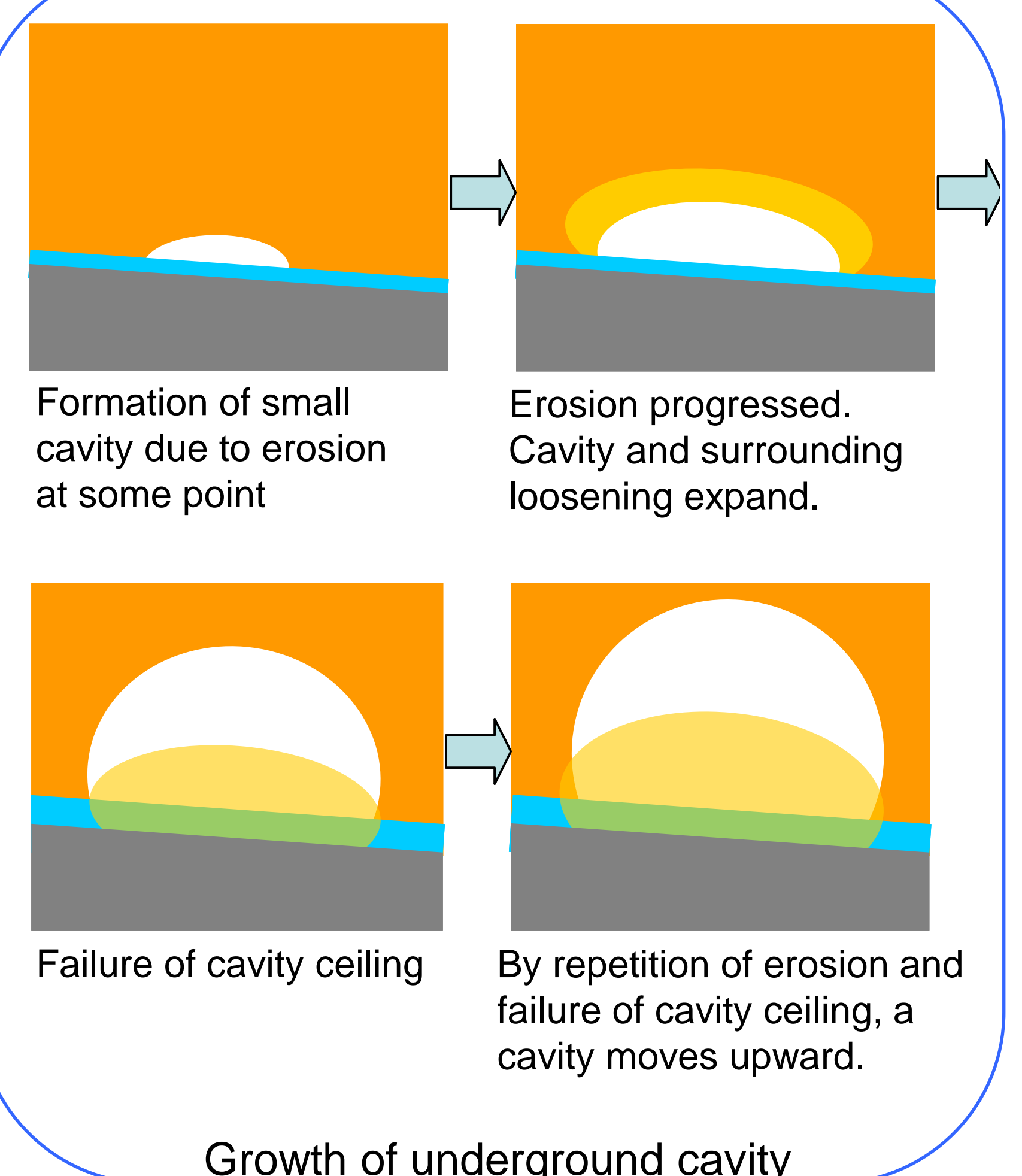
Hidden cavity in the ground



Soil pipe found at the location of cave-in



Possible path of soil transportation from the cavity



Growth of underground cavity