Ground stability

Fault reactivation

An unexpected hazard

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Fault movement is clearly seen in the city of Xian by the disruption of rigid brickwork and beams in buildings that straddle the fault trace.

The crust of the Earth is not an unbroken mass but is cut by countless fractures. The largest, such as the Mid Atlantic Ridge, define the plates that form the Earth's surface on which the continents move over geological time. The plates themselves are cut by major discontinuities, called faults, which have formed over millions of years as a result of the stretching and compression that the plates have suffered as they moved under the influence of convection currents deep in the Earth. The largest faults stretch for hundreds of kilometres, with relative displacements of the ground on either side of the fault ranging from metres to kilometres. In seismically active areas their sudden movement is the cause of major earthquakes. On a more human scale the apparently unblemished land where we live and work is also broken by fractures or faults that may be on a scale of tens of metres to tens of kilometres and are hidden from view by surface deposits, soil and vegetation. In most areas these faults are stable and have not moved for millions of years. However, they do represent a plane of weakness and can move if disturbed by a range of activities that change the stresses on them.

In British coalfields very large volumes of coal have been extracted from underground mines. This usually causes a relatively gentle lowering of the ground surface, sometimes by several metres. However, where a fault is present the movement may be taken up at the fault plane itself causing the fault to move and resulting in a fault scarp, perhaps several metres high, at the ground surface. A very clear example can be seen in the South Wales Coalfield that can be traced for hundreds of metres across the countryside. If such a scarp should impact on surface structures severe damage can ensue.

Another cause of fault activation can be the abstraction of groundwater. The city of Xian in central China is founded on a sequence, 700 metres in thickness, of river, lake and windblown (loess) deposits in a fault-bounded basin. The area is tectonically active and the city is crossed by eleven major faults, expressed as ridges in the weakly cemented loess, which move slowly in a manner called creep. They have not, in the past, caused insuperable problems to the city but the area is very dry and increases in population and industry have resulted in a greatly increased rate of extraction of groundwater. The pumping has resulted in a lowering of the level of the water table and this has caused the dewatered sediments to consolidate. Normally this would cause a gentle lowering of the ground surface, but in this area the movement was concentrated on the faults, which moved vertically at a maximum recorded rate of 180 millimetres per year. In some areas scarps up to 500 millimetres high developed, causing significant damage to roads, houses and factories. The problem was eased by decreasing the rate of abstraction.

Other causes of fault reactivation include increased pore water pressures as a result of the disposal of fluid waste down deep boreholes and increased loading of the Earth's crust due to the construction and infilling of large dams and reservoirs. These examples of fault reactivation illustrate the importance of having access to accurate maps and plans of faults in areas of development and appreciating the possible consequences of our activities on the balance of forces that permeate our surroundings.

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Fault scarps in the South Wales Coalfield believed to be due to reactivation by coal extraction.