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Cliff quivers warn of collapse

Philip Ball

Seaside cliffs may shake before they fall, giving hours of notice.

Walkers on seaside cliffs may be thankful of warning before a collapse.

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Tiny tremors can signal a collapsing cliff at least two hours before the rocks start to tumble, according to a team of French researchers.

The team spotted seismic signals in one seaside cliff before it collapsed, and say the same technique should work on other unstable pieces of land. The research, carried out by David Amitrano of the National Polytechnic Institute of Lorraine in Nancy and colleagues, has persuaded the French government to consider installing early-warning systems in other vulnerable sites, according to geologist Rory Mortimore of the University of Brighton, UK.

There is special concern about cliff collapse in France simply because many of its coastal towns are built along the clifftops, says Mortimore. He and the French team are both involved in a Europe-wide project to study erosion called PROTECT (Prediction of the Erosion of Cliffed Terrains).

Other nations have similar problems. In Denmark, which is one of the major players in the PROTECT scheme, cliffs on the Baltic coast are particularly prone to crumbling: a recent collapse killed a woman and dog walking on the beach below. The chalk cliffs of Dover and Beachy Head on the south coast of England also experience regular rock falls.

Amitrano says his proposal for a simple early warning system could save lives. "Two hours' warning does some good," agrees geologist Chris Scholz of Columbia University in New York. "It allows you to get people out of the way." Current warning systems, such as rockslide monitors on roads in the Alps, rely mostly on detecting the noise of a fall after it starts.

So far Amitrano's system is untested, so the team doesn't yet know how reliable or precise it could be. "We are working on that," he says.

Soft rock

Amitrano and colleagues chose a particularly vulnerable area to study: the chalk cliff at Mesnil-Val in Haute Normandie is eroding fast, retreating by up to a metre a year. It is particularly hard to detect seismic tremors in chalk, notes Mortimore, because the soft rock damps the quivers before they travel far. "If it works in chalk, it'll work in anything," he says.

They placed five seismic detectors in boreholes over a 60-metre section of the 50-metre-high cliff face. Vibrations in the rock were picked up by the sensors and converted to radio signals. These were then broadcast, using the French telephone network, to a data-analysis system in Amitrano's lab at Nancy that was continually monitoring the array's output.

Two hours before the collapse on 23 June 2002, one of the five sensors picked up activity that increased at an exponential rate until at least a thousand cubic metres of rock sheared away and fell on to the beach, the researchers report in *Geophysical Research Letters*[1]. The team thinks that similar precursors should occur in a predictable fashion for other collapses.

Seismologist Emile Okal of Northwestern University in Illinois says that detecting a precursor to a collapse event is "great news". But he

cautions that the real test will be whether this can be done in real time before the collapse, rather than retrospectively.

False alarms of rumbling without a collapse could cause unnecessary panic and evacuations, he adds. And it's not clear whether it would be feasible to install arrays of sensors over long sections of coastline.

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References

1. Amitrano D., Grasso J. R. & Senfaute G. *et al*. *G. Geophys. Res. Lett.* , **32**. L08314 (2005).

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