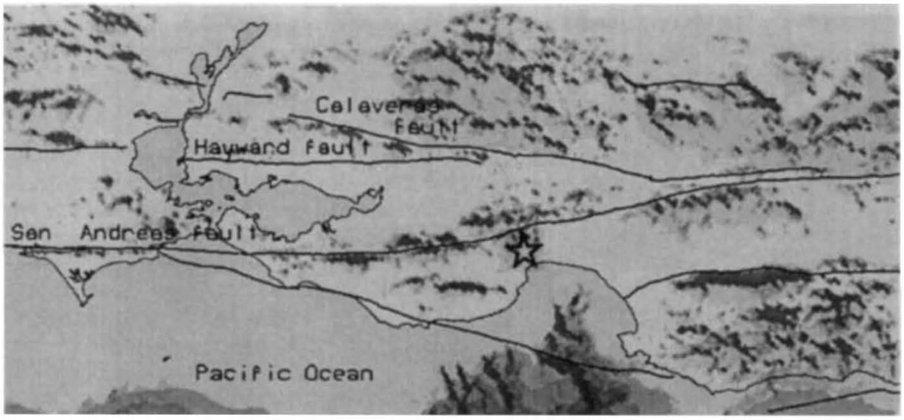

Shaded-relief map of central California and Pacific Ocean floor shown in oblique Mercator projection about the Euler pole of motion between the North American and Pacific Plates (49.6° N, 76.7° W). Throughout much of the region the plate boundary follows small circles (lines of latitude) about the Euler pole, principally as the San Andreas and Hayward faults. The Loma Prieta earthquake (star) occurred in the southern Santa Cruz Mountains, where the 10° anticlockwise bend of the San Andreas fault places the plate boundary into compression. Note the low topography along the symmetrically branching Calaveras fault, where plate motion creates a deep basin.

the southern Santa Cruz mountains.

But what of the earthquake forecast? Several voices have been raised suggesting that claims of success are invalid, because the Loma Prieta earthquake occurred sooner than anticipated or was not directly on the main trace of the fault. It is fair to say that none of the published forecasts called this event correctly in all respects, and none foresaw the reverse component of motion. As Wayne Thatcher (US Geological Survey, Menlo Park) has emphasized, the forecasts with the most accurate timing critically depend on the questionable, in his view, adoption of the displacement (1.5 m) measured at Wrights Tunnel rather than the larger geodetically averaged displacement as the appropriate value for the 1906 earthquake.

We shall never know what slip, if any, occurred on the Loma Prieta fault in 1906, nor can we be guaranteed that the spacing of such events is regular in time. Thus, in retrospect, we are fundamentally limited in our ability to tie these two events together quantitatively.

Forecasting the future, especially with little in the way of either theory or data, is an unsure proposition, at best. To me, the Loma Prieta event marks an important success for earthquake prediction, albeit a qualified one, as the evidence suggests that between two-thirds and all of the strain released in 1906 had reaccumulated by the autumn of 1989 — more along this section than anywhere else along the 1906 rupture. The complexity of both the fault zone and the forces that drive it, and our limited knowledge of each, all but guarantee uncertainty in predicting when and where dynamic slip will begin or end along the fault. Thus, we should not be terribly surprised if many of the details — including the precise slip plane — vary from cycle to cycle. Although we may hope that simple concepts, such as "time predictability"[7] grossly characterize the process, it is not proved. Indeed, the horizontal slip in 1989 released all of the strain expected to have accumulated since 1906, nominally making this component of displacement "slip predictable".

Loma Prieta poses another and perhaps ultimately more important dilemma for the would-be forecaster, as the elastic strain accumulated in the upper 4–5 km of the crust since 1906 was not released in October 1989, and there may still be significant potential for another strong event on this part of the San Andreas fault[5]. This possibility was considered by the Working Group on California Earthquake Probabilities[2], who concluded that a magnitude 7 event was unlikely (probability less than 0.01) and a magnitude 6–6½ event was considered possible, though a formal probability was not assigned. Others, including J. Behr (CIRES, University of Colorado) and co-workers[8] have reached a similar conclusion.

Some small comfort to the residents of the southern Santa Cruz mountains may be found in the observation that large magnitude earthquakes along the San Andreas fault system have historically involved energy release at depths well below 5 km. It is just in this deeper zone where the Loma Prieta earthquake released the stored strain along the fault zone. □

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DAEDALUS

Read my lips

ESPIONAGE agents, it is said, can monitor a conversation in a house from a point outside it by bouncing a laser beam off a window. The conversation vibrates the window like a microphone diaphragm; the Doppler modulation thus imposed on the reflected beam can be read from some way away. Daedalus is now using this cunning principle in a novel hearing aid. Conventional hearing aids are very imperfect. They disable the user's normal 'cocktail-party effect' discrimination; the jumbled mixture of amplified sounds which they deliver is very hard to interpret.

By contrast, Daedalus's laser-based hearing aid ignores sound completely, and responds only to vibrating surfaces. Its low-power solid-state infrared laser, mounted on a spectacle frame, projects a tight beam into the central region of the wearer's field of view: a speaker facing him, say. The speaker's mouth, and indeed his entire face, must vibrate in sympathy with the sound being generated inside it, and will modulate the laser light reflected from it. A photodiode receiver on the spectacle frame demodulates the returning signal, and drives a conventional amplifier and earpiece.

This wonderful device gives the wearer amazingly sensitive and directional hearing. Its range is almost unlimited; the laser beam is attenuated only slightly by distance. From the back of the most unruly lecture hall, it will reach out to the lecturer alone, and read his lips perfectly without interference. In the noisest party the wearer will hear only the companion facing him. To hear anyone else, even across a roomful of yelling people, he need only turn and look. He may even concentrate his gaze on the damnable background music that is forcing everyone to shout in the first place. Vibrating from its emitted sound, the loudspeaker will return a clear and uncluttered signal. Hearing will be almost as well-resolved as sight.

Engineers and musicians, even those with normal hearing, will rush to buy the new deaf aid. How useful for a choirmaster or conductor to be able to concentrate on just one singer or instrument in the vast polyphonic array before him! How convenient for a motor mechanic or service engineer to scan his gaze over the throbbing complexity of some malfunctioning monster, and hear the noise emitted by each component in turn! A more advanced, telescopic version would be ideal for diagnosing big industrial installations without leaving your office, or space rockets on the launch pad that cannot be safely approached. Even commanders in the field could use it to read the sonic signatures of the military hardware facing them, and the orders being given to deploy it . . . but now we're back to espionage again. David Jones