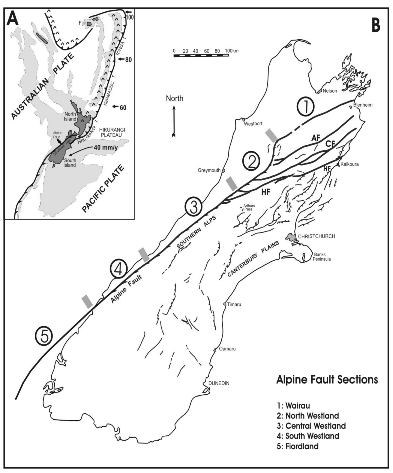
THE CANTERBURY UNIVERSITY STRONG-MOTION RECORDING PROJECT

Motivation for the design of the CUSP strong-motion accelerograph came from the high probability of a major rupture (M8+) on the Alpine Fault of New Zealand, prompting plans to install a dense network of instruments in the surrounding region to record the event.

Before the recent work of Yetton[1] in dating recent earthquakes on the Alpine Fault, it had been thought that the average recurrence interval for large events on the Fault was about 500 years. However, Yetton found convincing evidence for a recurrence interval of about 250 years, with characteristic earthquakes of around M8, and with the last event dated precisely at 1717; that is, about 290 years ago. This result, together with clear evidence of a seismic gap several decades long in the central South Island, suggests that a great earthquake is likely on the Fault within the next few decades, providing an excellent and rare opportunity to record strong shaking from such an event, in both the near and the far field,. The Engineering Seismology Group at the University of Canterbury intends to do that, and is working towards setting up a dense regional network of about 80 strong-motion instruments in the central South Island of New Zealand, in anticipation of a large earthquake on the Alpine Fault.



The South Island of New Zealand, showing the Alpine Fault

The Cusp-3A strong-motion accelerograph

The region is already served by a backbone set of instruments, generally 18-bit accelerographs, in the national network operated by GeoNet. The University group sought to add about 80 instruments, the "Canterbury Network", in three sub groups, as follows:

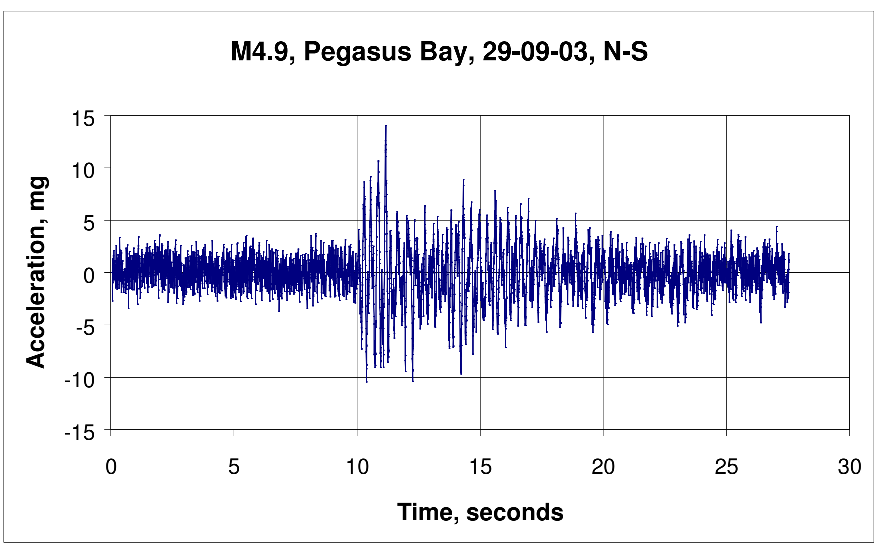
1. A dense array near the Alpine Fault, designed to follow the progress of rupture on that or nearby faults. This would comprise about 20 instruments, and the site favoured at present is near Cass..
2. A group of about 20 instruments at selected sites in the city of Christchurch, to record site effects on the highly variable fluvial and estuarine soils beneath the city.
3. About 30–40 instruments spread over the Canterbury Plains and the coastal plains of the Buller and West Coast regions, to record regional attenuation of strong ground motion.

[1] Yetton, M.D. (2000): The probability and consequences of the next Alpine Fault earthquake. Unpublished PhD Thesis. University of Canterbury library, Christchurch.

At the beginning of the project, the range of available instruments was limited. Traditional manufacturers focus on high dynamic range instruments with consequent high development and construction costs and thus high selling prices. This is unfortunate, since typical earthquake engineering applications require high spatial resolution, not high amplitude resolution. To address the problem of cost, both in initial outlay and ongoing maintenance, the Engineering Seismology Group worked with the Electrical and Electronic Engineering Department at the University of Canterbury to design a simple, low-cost, low-maintenance 13-bit accelerograph (CUSP) that employed the Internet for instrument monitoring and maintenance as well as for data transfer. The development of this instrument is the doctoral thesis topic of Mr Hamish Avery and the resulting strong-motion seismograph will be used in the Canterbury Network.

In designing the accelerograph, there were three main design objectives: The first was to keep the initial cost of the instrument low, the second, to minimise maintenance costs, and the third was to protect against component obsolescence. Of the first two, the latter is more important in the overall cost of running of a network. Experience has shown that the main cost in operating a network was in the routine maintenance of the instruments, with most of that cost being in travel to the dispersed sites. Thus, in designing the CUSP instrument much effort was given to minimising the need for site visits by remote monitoring of instrument status and remote down loading of records via the Internet. The construction cost was kept down by the use of micro machined (i.e. MEMs device) accelerometers, originally developed for the automotive industry to trigger car air bags, but subsequently made available with characteristics more suitable for seismology. Much of the design effort went into extracting better performance from these mass-produced devices by extensive calibration and data processing. Because strong-motion accelerographs have a long working life, a further design objective was to minimise vulnerability to obsolescence.

The instrument has undergone much testing on the laboratory shaking table at the University, but the first real earthquake was recorded at Ilam in late September 2003 from a M4.9 earthquake at an epicentral distance of 40 km, in Pegasus Bay. The low peak acceleration, of 0.015g, provided a strong test of the triggering system, which was set to 0.006g. The N-S component is shown in the figure below.



The first field record obtained by cusp, recorded on the ground floor of the school of Engineering, University of Canterbury.