Tales from a dead submarine cable

A derelict submarine cable linking Australia to New Zealand can still tell us a thing or two. The old Morse-code carrier, laid in 1912, has been lying idle on the sea-bed since 1967. Oceanographers have recently studied small signals induced in the cable by ocean currents moving above it.

The cable, essentially a 2270-km length of insulated wire, was a faithful carrier of vital telegraph messages between Sydney and Auckland until the newfangled coaxial cable came along.

Scientists have measured the voltage induced in the old cable by the flow of sea-water (a conductor) through the earth's magnetic field. In effect, the system is an almighty electrical generator, although, with a magnetic field of only 50 microtesla and a conductor velocity measured in centimetres per second, its output is minuscule — some hundreds of millivolts at most.

Dr Peter Baines and Dr Robert Bell, of the CSIRO Division of Atmospheric Research, analysed accumulated data from the cable, hoping that these might give them some direct measure of water flow through the Tasman Sea. Unfortunately — they concluded — the generating system is complicated by too many factors to make this possible.

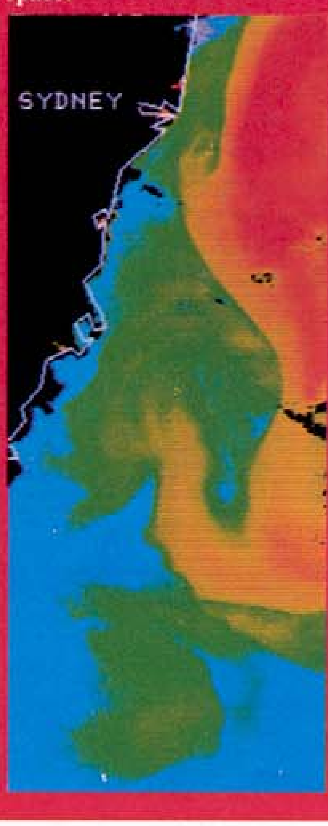
Michael Faraday was the first to realise that flowing water must generate a voltage. In 1832 he strung a wire across the Thames, but the electrical potential was too small to register. (Later workers, with better equipment, had more success.)

In recent decades, oceanographers have used cables spanning straits and channels (distances of up to 100 km) to measure water flow. However, until now, nobody had tried the technique over thousands of kilometres.

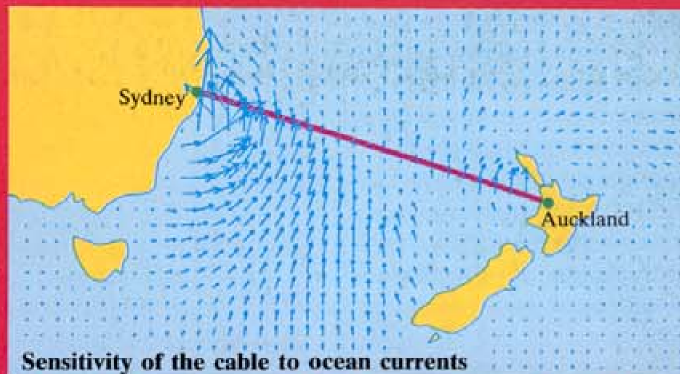
Major difficulties arise due to action of tides, variations in the earth's magnetic field, and short-circuiting of the signal by sediment and rock beneath the cable. The complicated mathematical modelling required to infer water flow from measured voltage can be formidable.

Dr Baines' good fortune, apart from the availability of a powerful computer, was access to more than 7 years' cable-voltage data collected by Professor Keith Runcorn of the University of Newcastle-upon-Tyne for another purpose — insight into the mysterious circulation of the earth's molten interior (which generates our protective magnetic field in the first place). With many years' data, Dr Baines reasoned, a good deal of extraneous variation could be averaged out.

The swirling warm East Australian Current, seen from space.



Laying cable earlier this century.



The length (and direction) of each arrow shows the cable's sensitivity to an ocean current of unit speed (and same direction) at that point. Due to conductivity and depth factors, the cable is most sensitive to currents near Sydney.

The most conspicuous features of the record are more-or-less-annual fluctuations of about 500 millivolts lasting several months. The two researchers found that the monthly average cable voltage from 1969 to 1976 correlated with the mean sea level at Sydney over the same period, suggesting that the cable was in fact responding to ocean currents.

However, despite initial expectations, the scientists could not correlate any individual voltage surges with any documented ocean movement. And the voltage did not correlate with sea-level records for Auckland, Lord Howe Island, or Norfolk Island.

Modelling showed why. As the diagram illustrates, the cable is much more sensitive to movements near Sydney than elsewhere (due to a combination of conductivity and depth effects). And so a relatively small eddy peeling off from the East Australian Current, and close to the coast, could produce these fluctuations.

For example, according to the model, an eddy at the latitude of Sydney with a radius of 100 km gives a voltage of +800 mV or −400 mV, depending on its distance off-shore.

The researchers reluctantly conclude that local effects swamp any signal generated by large-scale movements, thereby preventing us from having the flow meter we would like.

Andrew Bell

The relationship between ocean current transports and electric potential differences across the Tasman Sea, measured using an ocean cable. P.G. Baines and R.C. Bell. *Deep-Sea Research*, 1987, **34** (in press).