A palaeomagnetic study of the Fairfield Quarry section, Otago

P. Lurcock & G.S. Wilson, University of Otago

**Location & Setting**

Fairfield Quarry near Dunedin exposes a 25-metre Haumurian–Teurian section comprising non-marine (Taratua Formation) and shallow marine (Wanagola Formation) sands overlain by the glauconitic Fairfield Greensand and Abbessford Mudstone units. The location and age of this sequence makes it a potentially valuable recorder of the history of Antarctic glaciation. The section is exposed and thus permits detailed study of stratigraphy and sedimentary processes.

**Field Methods**

The face was sampled in 10 separate vertical sub-sections (designated B-K) at sites where exposure and access permitted. Sampling sites were picked at approximately 0.5m intervals along each sub-section, and 3-4 cores taken with a petrol and electric hand drill at each site. In total, around 200 oriented cores were obtained, yielding 1-4 specimens each. Magnetic susceptibility of the cleaned rock face was also measured at 3cm intervals from the bottom of section E to the top of section K. Relative positions of sites and sub-sections were established to high accuracy with a laser range-finder to allow integration of field data into a coherent section.

**Description of Section**

The section consists mainly of siltstone with little variation in grain size beyond gradation at the bottom from the underlying sandy unit. There are several strongly glauconitic horizons; these are usually associated with an abundance of burrow structures and sometimes with fossil wood fragments. Towards the top of the section is a prominent horizon containing large glauconitic concretions. The beds dip at around 6 degrees to the south-west, and the main face of the quarry below is either strongly south-south-west or 45 degrees. The upper face (sites H-K) is more nearly north-south oriented, as can be seen from the dipping beds in the photograph.

**Palaeomagnetic Behaviour**

Palaeomagnetic investigation of the Fairfield sediments presents significant challenges. Most of the samples have extremely weak remanences, generally under 5 x 10^-7 Am^2, necessitating special measurement techniques to overcome machine noise. Like most New Zealand sediments, these samples respond poorly to alternating-field demagnetization; thermal demagnetization was therefore necessary. Samples were progressively demagnetized by heating in 10°C steps to around 325°C, by which point the remaining magnetic signal was generally obscured by thermal alteration. Stable endpoints were rarely reached, but many demagnetization curves trended along great circles, allowing endpoints to be inferred from the intersections of projected great-circle paths. In spite of the very weak magnetic signal, this method should allow a polarity and approximate direction to be established for the characteristic remanent magnetism of each sampling site.

**Magnetic Susceptibility**

![Graph showing magnetic susceptibility measurements.](image)

On-site magnetic susceptibility measurements, recalibrated against accurate laboratory measurements of the discrete samples. The susceptibility peaks correspond to glauconitic horizons in the section.

**AMS Fabrics**

![Graph showing AMS fabrics.](image)

Throughout subsection B, the principal axis is horizontal with a declination close to zero, probably indicating a north-south bottom current during deposition.

**Discussion & Conclusions**

This data can furnish valuable insights into marine palaeoenvironment during the late Cretaceous and Palaeocene. The characteristic remanence from most sites analysed so far is consistent with deposition at high latitude and subsequent antitropical rotation. The glauconitic horizons and corresponding susceptibility excursions may be indicators of episodic currents driven by transient Antarctic glaciation. The AMS fabric requires further investigation, but its non-correlation with the remanence direction is already valuable as evidence against a diagenetic origin for the latter.