A PALÆOMAGNETIC STUDY OF THE FAIRFIELD QUARRY SECTION, OTAGO

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LOCATION & SETTING

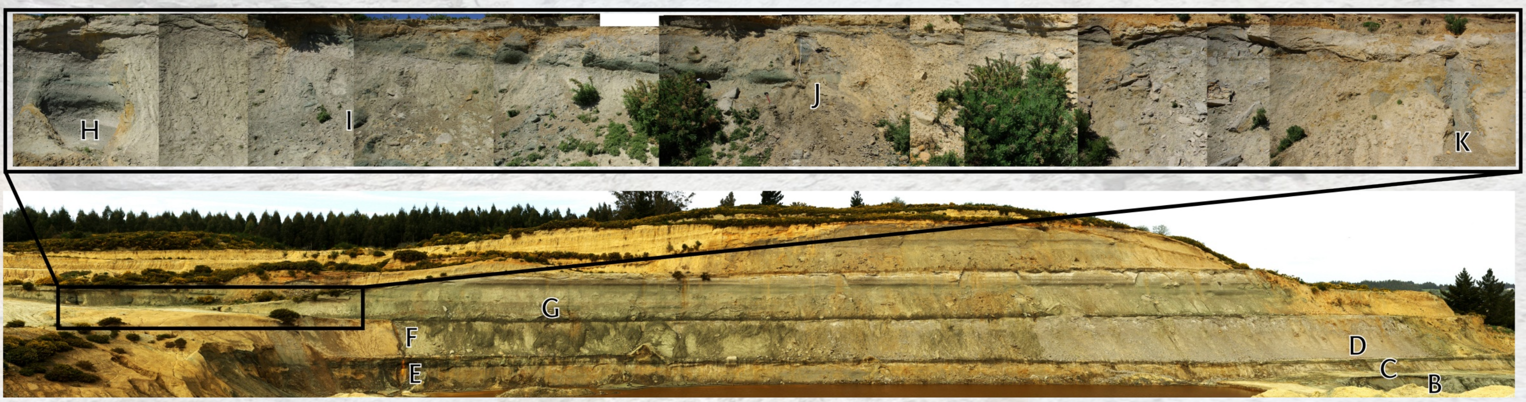
Fairfield Quarry near Dunedin exposes a ~25-metre Haumurian–Teurian section comprising non-marine (Taratu Formation) and shallow marine (Wangaloa Formation) sands overlain by the glauconitic Fairfield Greensand and Abbotsford Mudstone units. The location and age of this sequence makes it a potentially valuable recorder of the history of Antarctic glaciation prior to the establishment of a permanent Antarctic ice sheet, since changes in bottom water flow affect deposition. In particular, layers of autochthonous glaucony are linked with periods of very low sedimentation, and sedimentary fabrics can give indications of palæocurrent direction.

FIELD METHODS

The face was sampled in 10 separate vertical subsections (designated B–K) at sites where exposure and access permitted. Sampling sites were picked at approximately 0.5m intervals along each subsection, and 3–4 cores taken with petrol and electric hand drills 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 5cm 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

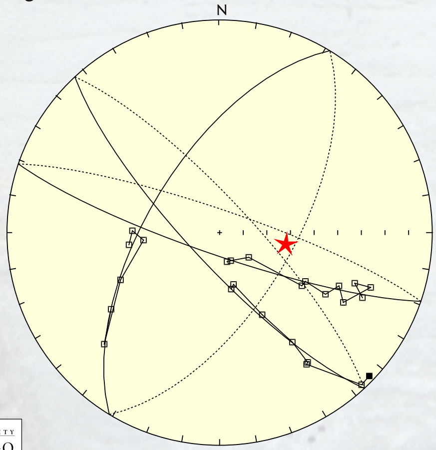
The section consists mainly of siltstone with little variation in grain size beyond gradation at the bottom from the underlying sandy unit. There are several strongly glauconitic horizons; these are usually associated with an abundance of burrow structures and sometimes with fossil wood fragments. Towards 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 (sites B–G) lies roughly along the strike (~45°). The upper face (sites H–K) is more nearly north-south oriented, as can be seen from the dipping beds in the photograph.



Southeastern face of Fairfield Quarry, showing sampling sites

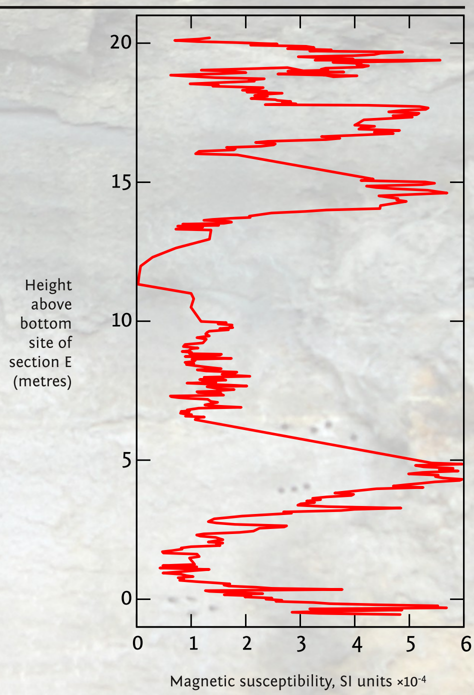
PALÆOMAGNETIC BEHAVIOUR

Palæomagnetic investigation of the Fairfield sediments presents significant challenges. Most of the samples have extremely weak remanences, generally under 5×10^{-5} A/m, 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 25°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.



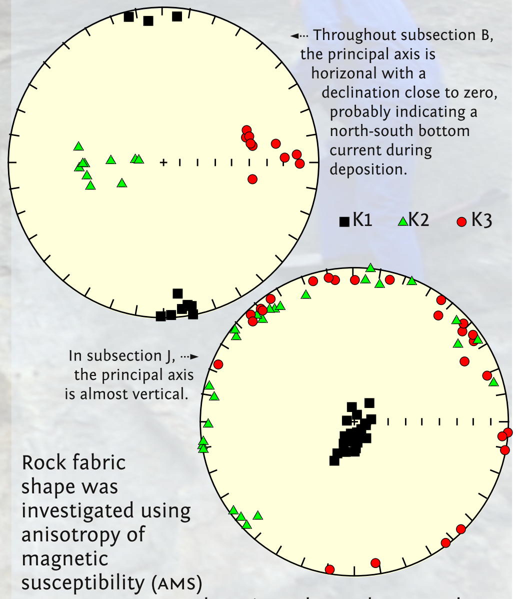
Demagnetization endpoint extrapolated from great-circle paths for site 3 of subsection E. Star marks estimate of actual direction. $\alpha_{95} = 0.87$, $k = 115$.

MAGNETIC SUSCEPTIBILITY



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



Rock fabric shape was investigated using anisotropy of magnetic susceptibility (AMS) measurements on the oriented samples. Samples from some sites exhibited a consistently oriented horizontal principal axis, probably indicating the direction of a palæocurrent. Several sites, however, have a strongly prolate (L>1.01 in some cases) anisotropy ellipsoid with a vertical or near-vertical principal axis. The cause of this unusual fabric shape is as yet unknown. It is more predominant in the upper subsections.

DISCUSSION & CONCLUSIONS

This data can furnish valuable insights into marine palæoenvironment during the late Cretaceous and Palæogene. The characteristic remanence from most sites analysed so far is consistent with deposition at high latitude and subsequent anticlockwise 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.

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