Tectonic Setting, Seismic Stratigraphy and Physical Properties for CRP-1

Introduction

Eight papers are presented in this section. The papers cover the regional tectonic setting, geophysical surveys of the drillsite, and a range of physical properties of the core.

The detailed seismic reflection and swath bathymetry data recorded over the drillsite in 1996 significantly extended the existing site survey data package, and are analysed in two papers. The first paper by Hamilton, Sorlien, Luyendyk, Bartek and Henrys, interprets these data in terms of the structural setting of the Roberts Ridge, on which the drillsite is located. Their detailed swath data define the morphology of the Roberts Ridge and identifies the Cape Roberts Rift Basin between the Roberts Ridge and the Victoria Land coast. Analysis of some 250 km of multichannel and medium resolution seismic reflection data identifies three sets of fault systems. Two sets of rift border faults strike NW and NNE and define the asymmetric graben of the Cape Roberts Rift Basin, which is inferred to have opened by tilting and vertical axis rotation of fault blocks forming the eastern margin of Cape Roberts Rift Basin (Roberts Ridge). A third set of ENE trending faults is concentrated towards the northern end of Roberts Ridge. From an analysis of the seismic stratigraphy, they infer that the Cape Roberts Rift Basin postdates the major rifting phases which formed the older part of Victoria Land Basin. Magnetic data recorded during the survey are consistent with the igneous bodies under western Cape Roberts Rift Basin inferred from earlier aeromagnetic data.

A complementary paper by Henrys, Bartek, Brancolini, Luyendyk, Hamilton, Sorlien and Davey, uses the same seismic dataset, supplemented by earlier seismic data from US and Italian sources, to correlate the seismic stratigraphy for the Victoria Land Basin (Cooper & Davey, 1987) with the seismic sequencies at the drillsite and to other drillholes in the region. The analysis focuses on the V3/V4 sequence boundary, and the correlation is made in two ways. One is directly across the Roberts Ridge to the drillsite, where the seismic events of interest have to be traced (using limited MCS data) through the seafloor multiple, below which they are poorly defined. The second correlation uses seismic datasets around the northern end of Roberts Ridge, where the shallower seismic events of interest do not lie beneath the seafloor multiple and are thus clearer. The two interpretations give different correlations at the CRP drillsite location, about 100 ms (100 m) different in depth. The results of drilling CRP-2 should date these events, but this will still leave the fundamental problem of the age of V3/V4 in the main Victoria Land Basin.

An associated study by Bücker, Henrys and Wonik reviews the physical properties data for the sediments at the CIROS-1 drillsite, about 70 km south of CRP-1, in order to derive a better synthetic seismogram for the drillhole and to improve its correlation with seismic reflection data. This would then improve correlation between strata cored at the two drillsites. Their analysis derives a revised porosity-depth function that is similar to that obtained at CRP-1, and from this they derive a new velocity-depth function. The velocities obtained are significantly lower than the original estimates and give a synthetic seismogram that fits well with the observed seismic data.

Three papers cover the physical properties of the core sediments. The physical properties of the core from detailed measurements made along the whole core are discussed by Niessen, Jarrard and Bücker, and by Niessen and Jarrard. A suite of measurements (P-wave velocity, wet bulk density and magnetic susceptibility) and their relationship to lithology and variation with depth below seafloor are reported by Niessen, Jarrard and Bücker. Anomalously steep porosity gradients are interpreted to be indicative of over-consolidation, even for some non-diamict units. Exhumation of the Miocene sediments in the upper part of the core is estimated to be between 200 and 700 m. Magnetic susceptibility
measurements show two major features. An increase in the susceptibility in the upper part of the core is inferred to relate to the commencement of the McMurdo volcanism at about 19 Ma. In addition, cyclicity in susceptibility is noted beneath but the reason for this is unclear. In a companion paper (Niessen & Jarrard), the relationship of P-wave velocity with porosity for the core sediments is investigated and compared with similar result from core-plugs (Brink & Jarrard) and global models. P-wave velocities from both core-plugs and whole-core measurements show a strong correlation with porosity, but appear independent of lithology. In the lower porosity range, the velocities from core-plugs are generally higher than the whole-core measurements and a number of possible interpretations are discussed. Clay content is considered to have a second order effect on velocity. Brink and Jarrard also discuss measurements of velocity at different pressures, bulk density, porosity, matrix density, and magnetic susceptibility for 18 core plugs. Generally the measurements are in close agreement with the whole-core measurements (Niessen, Jarrard & Bücker, noted above). Velocity versus pressure measurements indicate the in-situ velocities are very close to measurements at atmospheric pressure, and it is suggested that velocity response to pressure is largely dominated by a small amount of post-exhumation cementation.

The final two papers in this section have studied fracture arrays in the core and methods of orientating them. Wilson and Paulsen have identified sets of natural and induced fractures of varying types in the core. The natural fracture sets document a normal faulting type stress regime with a vertical maximum principal stress. Palaeomagnetic data have been used to orient cores where these data are adequate (Paulsen & Wilson) and some success is indicated based on a reduction in the scatter of observed fractures. Using these orientated core intervals, a north-northeast - south-southwest contemporary maximum horizontal stress is derived for the Cape Roberts region, compatible with the previously inferred regional late Cenozoic dextral transtension along the Transantarctic Mountains Front.

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REFERENCES