

Provenance and Climate from Petrology for CRP-2/2A

Introduction

The nine papers in this section present the results of investigations of bulk sediment samples and of the different detrital components (clasts, sand grains, mud, clay minerals, heavy minerals and ferrimagnetic minerals) throughout the 624 m long CRP-2/2A drillcore. In addition to the analysis of the environmental magnetic properties, a wide range of petrological and geochemical methods was used in order to get a more definitive characterization of the lower Oligocene to Quaternary sedimentary sequence, and to obtain new information about the sediment source area, the erosional and uplift history of the Transantarctic Mountains and the Cenozoic palaeoclimatic record of the Ross Sea region.

Clasts (granule to boulder grain-size) were investigated both petrographically and chemically, by electron microprobe and XRF, as well as for their distribution patterns (Talarico et al.). Compositional and modal data provides a clear evidence of a multi-component source and of a varied, but local, provenance which closely mirrors the present-day on-shore geological units of the Transantarctic Mountains in southern Victoria Land. The clast data also point to presence of significant fluctuations in the relative proportions of the main lithologies with a major change in the distribution pattern in correspondance of a major unconformity at 307 mbsf, with basement granitoid-dominated clasts above and mainly Ferrar dolerite clasts below.

Sand-grade samples were investigated petrographically for their detrital modes (Smellie). This study provides further evidence of a major petrological break located at 307 mbsf, with sand grains dominantly derived from Beacon sandstones and Ferrar dolerite source below, and a main contribution from basement granitoids above. Sand grain compositions also indicate an input of fresh volcanic detritus, petrographically similar to the McMurdo Volcanic Group. This contribution is restricted to the sequence above the 307 mbsf unconformity and it documents at least three episodes of volcanism including several tephra layers.

Bulk samples of all lithology types were investigated by XRD for their mineralogical composition (Neumann & Ehrmann). This study showed that quartz, plagioclase feldspar and K-feldspar are the most important non-clay minerals in the sediments, but amphiboles and pyroxenes also occur in minor amounts throughout the core. This composition also points to a source area in the Transantarctic Mountains and a progressive shift from a source in the Beacon Supergroup to a basement-dominated source. Evidence of diagenetic alteration was reported by the occurrence of zeolites and of opal-CT, below and above c. 320 mbsf, respectively.

XRD, TEM and petrographical techniques were used to investigate separate sediment fractions for their clay mineral assemblages (Ehrmann), smectite composition (Setti et al.) and heavy mineral composition (Polozek). The studies of the heavy minerals further substantiate the provenance-dependent composition of the sediments and the results are consistent with those from analyses of the composition of the gravel and sand fractions. The assemblage is dominated by pyroxenes. Hornblende, zircon, garnet, epidote, titanite, apatite, titanite, glass, opaque minerals and altered minerals are quantitatively minor. Below c. 270 mbsf the heavy minerals indicate a source in the Transantarctic Mountains. Above 270 mbsf, an additional volcanic component occurs. The investigations of the clay mineral composition and content document another first-order petrological boundary (at c. 485 mbsf) (Ehrmann). This boundary is represented by a shift from smectite-dominated (below 485 mbsf) to smectite-poor and illite-rich assemblages (above). These data provide evidence for a significant change in the palaeoweathering conditions in the source area, from a phase of active chemical weathering over large ice-free areas to a phase when physical weathering prevailed on an ice-covered continent.

XRF geochemical analyses of bulk core samples of mudstones and siltstones (Krissek & Kyle) and of sandstones (Bellanca et al.) were used to investigate provenance and palaeoweathering intensities in the source. These studies again document a major provenance change at c. 310 mbsf, *i.e.* a provenance dominated by the granitoid basement with a significant

contribution of the McMurdo Volcanic Group above, and by the Beacon Supergroup and Ferrar Group (Ferrar dolerite and Kirkpatrick lavas) below. In contrast to clay mineral data, chemical index of alteration (CIA) values are relatively uniform throughout the core (Krissek & Kyle), indicating relatively consistent palaeoweathering intensities throughout the Oligocene and early Miocene in the sediment sources for CRP-2/2A. As stated by Krissek & Kyle these inconsistencies may however reflect differences in the sensitivities of the different palaeoweathering indicators and a more detailed interpretation of CIA values should be examined by additional studies after the overprint of provenance changes has been removed using mixing models and comprehensive trace element analyses.

Finally, an analysis of the environmental magnetic properties (Verosub et al.) suggests a subdivision of the core into three intervals. In the uppermost interval (above 270 mbsf) magnetite is the dominant magnetic minerals and variations in magnetic parameters correlate with fluctuations in volcanic glass contributions from the McMurdo Volcanic Group. The two lowermost intervals (270-413 mbsf, 413-624 mbsf) are differentiated on the basis of their mean coercivity values. They are marked by alternations between zones relatively enriched in magnetite and hematite, respectively, most likely reflecting changes in palaeoenvironmental conditions related to climate and weathering regime below the threshold required to detect similar changes in clay mineral assemblages.

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