Diagenetic and Physical Properties of Pelagic Carbonate Sediments: ODP Leg 130, Ontong Java Plateau

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAII IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

OCEANOGRAPHY

MAY 1994

By

Jozsef Urmos

Dissertation Committee:

Fred Mackenzie, Chairman
Alexander Malahoff
Michael Mottl
Jane Tribble
Roy Wilkens

ABSTRACT

The thick, continuous sequence of carbonate–rich pelagic ooze, chalk and limestone sediments on the Ontong Java Plateau was extensively sampled along an equatorial depth transect at five sites during Ocean Drilling Program Leg 130. Recovery of sediments from incrementally different depositional settings facilitated a systematic analysis of diagenetic and physical properties. Geochemically important diagenetic processes are organic matter degradation and sedimentary carbonate recrystallization. Although bulk organic matter has C/N molar ratios near Redfield values (5–9), the labile fraction susceptible to oxidation via sulfate reduction has much higher ratios (25–82) that progressively increase in direct relation to the intensity of early oxic diagenesis. Organic diagenesis affects $\Delta Mg/\Delta Ca$ gradients through alkalinity production and Ca^{2+} depletion by calcite precipitation. A simple correction yields conservative $\Delta Mg/\Delta Ca$ gradients, which reflect the intensity of basaltic basement alteration. Effects of carbonate diagenesis were evaluated using bulk sediment Sr/Ca, Mg/Ca, and Na/Ca analyses. Sr/Ca data retain a strong paleochemical imprint only slightly affected by diagenesis, even within limestones. Mg/Ca variations are complex and display no obvious trends. Na/Ca values decrease progressively with depth in response to recrystallization. Diagenetic modelling using pore water Sr^{2+} data from ooze–chalk sections reveals that nearly two–thirds of total recrystallization occur within 5-10 m.y. in oozes, and compares favorably with the pattern and extent of recrystallization estimated from sediment Sr/Ca. From comparisons of diagenetic indicators and physical properties, the ooze–chalk transition appears to be primarily related to the compactional and textural evolution of the sediments and only secondarily related to chemical diagenesis.

Laboratory physical properties and in situ borehole well–logs from ooze–chalk

sections were compared to evaluate the accuracy of laboratory measurements. Laboratory porosity and bulk density compare favorably with logs and are minimally affected by pore water expansion; no mechanical sediment rebound was observed. Laboratory velocities compare poorly with sonic logs because of overburden pressure removal. Laboratory velocities were corrected as a function of burial depth or overburden pressure using exponential relationships, which are broadly applicable to pelagic calcareous sediments ($CaCO_3 > 60\%$) in different oceanographic settings, especially for making detailed correlations of sedimentary and seismic stratigraphies in situations where logging data are unavailable.