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12. Data Report: Whole-Rock $^{87}Sr/^{86}Sr$ Composition and Apparent Strontium Isotopic Age of Limestones from Site 1118, Woodlark Rift Basin, Southwest Pacific (Ocean Drilling Program Leg 180)[1]

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INTRODUCTION

Limestone from Unit VI (857.1–859.15 meters below seafloor) collected at Site 1118 contains a planktonic foraminiferal fauna indicating a latest Miocene to early Pliocene age. *Globorotalia tumida* is recorded in Sample 180-1118A-68R-4, 46–48 cm, indicating an early Pliocene (N18) age at this level (J. Resig, pers. comm., 2000). Based on their known range in the western Papuan Basin, the presence of (rare) *Lepidocyclina* and common *Amphistegina* in some samples suggests that abundant shallow-water bioclastic debris present in these limestones may be reworked from older, possibly middle or early late Miocene sediments. Four samples were selected for whole-rock strontium isotopic analysis to further investigate this possibility. A petrographic examination of samples analyzed was also conducted.

[1] Allan, T., Robertson, A.H.F., Sharp, T.R., and Trotter, J., 2001. Data report: Whole-rock $^{87}Sr/^{86}Sr$ composition and apparent strontium isotopic age of limestones from Site 1118, Woodlark rift basin, southwest Pacific (Ocean Drilling Program Leg 180). *In* Huchon, P., Taylor, B., and Klaus, A. (Eds.), *Proc. ODP, Sci. Results,* 180, 1–5 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/180_SR/VOLUME/CHAPTERS/158.PDF>. [Cited YYYY-MM-DD]
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METHODS

Sampling

Sample suitability for isotopic analysis was assessed petrographically in thin section using transmitted plane and polarizing light and in reflected light with a low-power stereomicroscope. Thin sections were stained with alizarin red to indicate dolomite. A dental drill with a diamond-impregnated bit was used to collect "whole-rock" samples including matrix and clasts. This approach was adopted as no discrete bioclasts were large enough to sample as fossil isolates.

Isotopic Analytical Techniques: Chemical Separation and Mass Spectrometry

Acetic acid was used for sample (powder) dissolution to minimize the dissolution of secondary dolomite and the extraction of Sr from clays and other terrigenous material (DePaolo et al., 1983). All samples yielded a gray-white residue. Strontium was extracted using conventional cation exchange techniques.

Isotopic compositions were measured at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) radiogenic isotope facility at North Ryde (Sydney, Australia) using a VG 354 thermal ionization mass spectrometer. $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr$ = 0.1194 using an exponential correction law and Rb corrections applied. External and internal precision (Table T1) is quoted at 95% confidence limits calculated as 2 standard errors of the mean (2 sem) (Table T1). SRM987 was the primary standard used, and all data were normalized to SRM987 $^{87}Sr/^{86}Sr$ = 0.710235. The estimated external precision based on SRM987 at the time of analysis was ±0.0024% or ±0.000017. A carbonate sample (EN-1) from a giant clam *(Tridacna)* from Enewetak Atoll (Ludwig et al., 1988) is used at CSIRO as a secondary standard. The long-term precision of the measurement for this standard (~±0.0028%) is comparable with that for the SRM987 standard, which suggests sample dissolution and chemical separation are not introducing any systematic errors.

T1. Ages of limestone samples, p. 5.

Age Calculations

Strontium isotopic ages are calculated with the equations of Oslick et al. (1994) that represent four linear approximations valid for ages between 9.9 and 35.4 Ma. Error in age assignment induced from the measurement alone over the 9.9- to 15.2-Ma segment of the Oslick seawater curve is ±0.75 Ma, assuming a measurement error of ±0.000020. Error associated with the seawater curve has been rigorously evaluated (Oslick et al., 1994).

RESULTS

Petrography

The four analyzed limestones are cream gray, tinged pale green, and are poorly to moderately indurated, with the exception of Sample 180-1118A-68R-3, 124–127 cm, which is more indurated. The microfabric and texture of all samples is similar; they are mud packed, poorly sorted, bioclastic limestones (packstones to rudstones) with no evidence of in situ biogenic binding. Compositionally they are also similar, with a distinct mixture of planktonic foraminifers and variably fragmented bioclasts of a shallow-water fauna that includes barnacles, bryozoans, corals, coralline algae, green algae, echinoid, "larger" benthic foraminifers, and encrusting forms. Off-center equatorial sections of *Lepidocyclina* sp. were observed in samples Sample 180-1118A-68R-3, 124–127 cm, and 68R-4, 60–62 cm. Minor (<2%) angular volcanigenic detritus is present in all samples and includes plagioclase, quartz, and amphibole.

All samples show petrographic evidence of diagenesis; vuggy matrix porosity and mouldic dissolution of aragonitic coral and green algal fragments. These molds are partially to fully occluded with a fine to medium crystalline, equant to columnar clear calcite spar, forming a drusy mosaic in some molds. An irregular sub-50-µm lining of finely crystalline, clear equant calcite is present in the vuggy porosity. The alizarin stain did not indicate any dolomite.

Strontium Isotopic Composition and Age

Measured $^{87}Sr/^{86}Sr$ ratios (Table **T1**) lie within a narrow range between $^{87}Sr/^{86}Sr$ = 0.708873 and $^{87}Sr/^{86}Sr$ = 0.708812 and increase upsection from Sample 180-1118A-68R-4, 9–11 cm. The lowest Sample 180-1118A-68R-4, 60–62 cm, however, has a significantly lower ratio than the overlying limestone ($^{87}Sr/^{86}Sr$ = 0.708851). Carbonate diagenetic alteration, including dissolution and cement precipitation, is present in the samples, and some volcanigenic material is also present.

The measured strontium isotopic compositions of all samples lie within a narrow range, suggesting they consistently reflect the bulk $^{87}Sr/^{86}Sr$ composition of carbonate present. There is no petrographic evidence that the latest Miocene–early Pliocene planktonic foraminiferal fauna is a secondary infill ("stratigraphic leak"). The significantly older late middle Miocene "Oslick" age of ~12 Ma indicated for this interval from bulk isotopic composition (Table **T1**) may therefore reflect significant input of older reworked shallow water carbonate debris. The presence of *Lepidocyclina* and (more frequent) *Amphistegina* suggests such a process; as in the western Papuan Basin, *Lepidocyclina* appears to range only as high as the earliest late Miocene (Allan et al., 2000), and *Amphistegina* is common in the same time interval.

The anomalous whole-rock ages may also reflect some direct or diagenetic contamination of the carbonate strontium isotopic composition by mafic volcanigenic detritus present in the samples.

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Table T1. Sr isotopic composition and calculated ages of limestone samples from Unit VI (857.1–859.15 mbsf).

Core, section, interval (cm)	Depth (mbsf)	$^{87}Sr/^{86}Sr$	2 sem (%)	Oslick age (Ma)
180-1118A-				
68R-3, 124–127	853.30	0.708873	0.0017	11.3
68R-3, 137–140	853.43	0.708844	0.0018	12.4
68R-4, 9–11	853.65	0.708812	0.0018	13.6
68R-4, 60–62	854.16	0.708851	0.0016	12.1

Notes: $^{87}Sr/^{86}Sr$ ratios normalized to $^{87}Sr/^{86}Sr$ = 0.1194. $^{87}Sr/^{86}Sr$ ratios normalized to NBS-987 $^{87}Sr/^{86}Sr$ = 0.710235. Measured NBS-987 $^{87}Sr/^{86}Sr$ = 0.710244 ± 0.0024% (±0.000017) (95% confidence limits). 2 sem = 2 standard errors of the mean ($2\ \sigma/\sqrt{n}$).