

# Mesozoic invasion of crust by MORB-source asthenospheric magmas, U.S. Cordilleran interior

Janet A. Leventhal  
Mary R. Reid  
Art Montana  
Peter Holden

Department of Earth and Space Sciences, University of California, Los Angeles, California 90024

Isotope and concentration data and description of laboratory procedures, for the GSA Data Repository

TABLE 1. Sr and Nd ISOTOPE DATA FOR XENOLITHS FROM CIMA VOLCANIC FIELD, MEASURED IN THIS STUDY

Sample	Rock type	$^{87}\text{Sr}/^{86}\text{Sr}$	$^{143}\text{Nd}/^{144}\text{Nd}$	$\epsilon_{\text{Nd}}$
C-13-1c	green-pyroxene opx gabbro	$0.70296 \pm 3$	$0.513098 \pm 9$	8.97
C-13-1f	green-pyroxene opx gabbro	$0.70281 \pm 1$	$0.513060 \pm 5$	8.29
C-13-2	green-pyroxene olivine gabbro	$0.70288 \pm 1$	$0.513108 \pm 5$	9.17
C-13-3	green-pyroxene cpx norite	$0.70266 \pm 3$	$0.513124 \pm 9$	9.48
C-13-4	green-pyroxene olivine websterite	$0.70288 \pm 2$	$0.513095 \pm 6$	8.91
OD-C16-11	green-pyroxene cpx norite	$0.70276 \pm 1$	$0.513074 \pm 13$	8.50
90C16-107	green-pyroxene opx gabbro	$0.70278 \pm 1$	$0.513097 \pm 6$	8.95

TABLE 2. Rb-Sr and Sm-Nd ISOTOPE AND CONCENTRATION DATA FOR A GABBROIC XENOLITH AND MINERAL SEPARATES FROM CIMA VOLCANIC FIELD, MEASURED IN THIS STUDY

Sample	Rb	Sr	$^{87}\text{Sr}/^{86}\text{Sr}$	Sm	Nd	$^{143}\text{Nd}/^{144}\text{Nd}$
whole rock (OD-C16-11)	2.60	203	$0.702760 \pm 8$	0.38	1.23	$0.513074 \pm 13$
plagioclase	0.80	436	$0.702715 \pm 7$	0.15	0.75	$0.513043 \pm 13$
clinopyroxene	0.05	2.40	$0.702766 \pm 13$	0.30	0.62	$0.513137 \pm 19$
glass-rimmed orthopyroxene 1	2.47	5.34	$0.703980 \pm 14$	0.31	0.74	$0.513101 \pm 8$
glass-rimmed orthopyroxene 2	2.32	4.03	$0.704339 \pm 10$	—	—	—

Note for Tables 1 and 2:

Rock types conform to IUGS classification (Streckeisen, 1976). Element concentrations are in ppm. Sample weights were 90-190 mg for minerals and 30-50 mg for whole rocks. Minerals were separated with a magnetic separator and handpicked under a microscope to a high degree of purity (<0.5 % impurity), except that glass-rimmed orthopyroxene 1 had minor attached plagioclase. Mineral separates were leached in 2.5 N HCl for 3 minutes and then repeatedly rinsed with 18-megaohm deionized water. The samples were dissolved for a few days in screw-top teflon beakers in a 1:3 mixture of concentrated HNO<sub>3</sub> and HF, then 7 N HNO<sub>3</sub>, and finally 6 N HCl. For samples in Table 2, approximately 1/3 of each solution was separated for spiking with mixed <sup>149</sup>Sm-<sup>150</sup>Nd and mixed <sup>87</sup>Rb-<sup>84</sup>Sr. Sr and REE were separated using standard cation exchange techniques. Nd was separated from other REE by cation exchange similar to the method of Richard et al. (1976).

All isotopic ratios were determined by thermal ionization mass spectrometry and, except as noted below, were performed at UCLA. Sr isotope compositions for samples C-13-1c, C-13-3, and C-13-4, and isotope dilution measurements for Rb and all blanks, were determined on a semiautomated VG 54E single-collector instrument utilizing single zone-refined Re or Ta filaments. All other Sr isotope compositions and Sr isotope dilution measurements were determined on a multicollecting VG Sector in peak-switching mode, utilizing single zone-refined Re or Ta filaments. All Sr samples were loaded in 5% or 10% H<sub>3</sub>PO<sub>4</sub>, with SpecPure Ta<sub>2</sub>O<sub>5</sub> added to samples run on Re filaments. Nd isotope compositions for the first five samples listed in Table 1 were determined on a Finnigan Mat 261 instrument (University of California at Santa Barbara) utilizing a double Re filament assembly and run in static mode. All other Nd isotope analyses and all Sm and Nd isotope dilution measurements were performed on a seven-collector VG 54-30 via a triple zone-refined Re assembly and were also run in static mode.

Sr and Nd isotope ratios were normalized for mass fractionation to <sup>86</sup>Sr/<sup>88</sup>Sr = 0.1194 and <sup>146</sup>Nd/<sup>144</sup>Nd = 0.7219 respectively, using the exponential fractionation laws described in Russell et al. (1978). Total-process blanks for Sr and Nd were 150 to 300 pg and 40 to 200 pg

respectively, which represent at worst <0.25% of the Sr and <0.7% of the Nd analyzed. Average  $^{87}\text{Sr}/^{86}\text{Sr}$  for SRM 987 run on VG Sector was  $0.710261 \pm 4$  (twice the standard error of 69 analyses); average  $^{143}\text{Nd}/^{144}\text{Nd}$  for La Jolla run on VG 54-30 was  $0.511857 \pm 5$  (twice the standard error of 38 analyses). Errors quoted in tables—representing internal (in-run) precision—are twice the standard error of the mean; errors used for  $^{143}\text{Nd}/^{144}\text{Nd}$  and  $^{87}\text{Sr}/^{86}\text{Sr}$  in the isochrons are either this internal precision of the analysis or the estimate of external reproducibility ( $15 \times 10^{-6}$  for  $^{143}\text{Nd}/^{144}\text{Nd}$  and  $20 \times 10^{-6}$  for  $^{87}\text{Sr}/^{86}\text{Sr}$ ), whichever is greater.  $\epsilon_{\text{Nd}}$  is the fractional deviation, in units of parts per  $10^4$ , from the present-day chondritic ratio, which is taken as  $^{143}\text{Nd}/^{144}\text{Nd} = 0.512638$ .

Richard, P., Shimizu, N., and Allègre, C.J., 1976,  $^{143}\text{Nd}/^{146}\text{Nd}$ , a natural tracer: An application to oceanic basalts: *Earth and Planetary Science Letters*, v. 31, p. 269-278.

Russell, W.A., Papanastassiou, D.A., and Tombrello, T.A., 1978, Ca isotope fractionation on the Earth and other solar system materials: *Geochimica et Cosmochimica Acta*, v. 42, p. 1075-1090.

Streckeisen, A., 1976, To each plutonic rock its proper name: *Earth-Science Reviews*, v. 12, p. 1-33.