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Geophysical and Geologic Studies at Valu Fa Ridge, Lau Basin, Southwest Pacific Ocean

The Lau basin is an actively spreading back-arc basin located west of the Tonga subduction zone and Tofua volcanic arc in the southwest Pacific Ocean. In the southern part of the basin is Valu Fa Ridge, a north-northeast-trending ridge located approximately 40 km west of the Tofua volcanic arc axis. There, spreading is occurring at a rate of 7 cm/year. Seven multichannel seismic reflection profiles over Valu Fa Ridge show a strong reflection 3.5 km beneath the sea floor. The inverted polarity of the reflection indicates that it is from a low-velocity zone, which is interpreted as the top of a flat, 2 to 3-km wide, axial magma chamber. The reflection coefficient indicates a large acoustic impedance contrast between the material above and below the reflector, possibly because a thin gas-rich layer is present at the top of the chamber.

Two dredge hauls from the crest of Valu Fa Ridge recovered highly vesicular andesites that are relatively homogeneous, both mineralogically and chemically. Dredge-1 rocks average 57.5% SiO<sub>2</sub>, 11.8% FeO (total Fe as FeO), 3.3% MgO, and 0.52% K<sub>2</sub>O; dredge-2 rocks have average values of 55.5% SiO<sub>2</sub>, 12.9% FeO (total Fe as FeO), 3.8% MgO, and 0.43% K<sub>2</sub>O. Average isotopic values are <sup>87</sup>Sr/<sup>86</sup>Sr 0.70330 ± 2; <sup>143</sup>Nd/<sup>144</sup>Nd 0.51303 ± 2; <sup>206</sup>Pb/<sup>204</sup>Pb 18.65 ± 2; <sup>207</sup>Pb/<sup>204</sup>Pb 15.55 ± 1; and <sup>208</sup>Pb/<sup>204</sup>Pb 38.34 ± 4. Trace-element averages (ppm) are Sr 167, Rb 7, Cs 0.18, La 4.2, Eu 1.3, Lu 0.56, Y 37, and Zr 78. Isotopic data are similar to data from rocks of the Tofua arc and overlap the relatively enriched MORB fields. High Cs, Rb, Th, U, and K contents are characteristic of an arc component in the melt. These chemical data indicate a small but significant subduction-zone effect on the Valu Fa andesites.

The presence of hydrothermal manganese crusts as much as 10 mm thick and nontronite in the dredge hauls, elevated concentrations of particulate and total dissolvable manganese in the water column above Valu Fa Ridge, and small bottom-water temperature anomalies indicate that hydrothermal circulation is occurring at the ridge.