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Title: Northern Tonga Arc and Fonualei Rifts: initial results from the NoToVE (SS11/2004) Research Voyage

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Abstract: The NoToVE research voyage (SS11/2004 of the RV Southern Surveyor in the northernmost Tonga Arc-Fonualei Rifts discovered numerous stratovolcanoes of variable complexity, and steep-walled calderas with diameters <12 km. Large-scale sector collapses occur on many of these structures, and concentric ridges on the outer flanks of some calderas appear to be mega-bedforms associated with mass flows and edifice failures. Topographic rims of many calderas are capped by numerous conical vents. The compositional range of lavas in the Tonga arc is from high-Mg basalt to rhyolite (some quartz-amphibole-bearing). A number of the satellite cones have erupted primitive, glass-rich olivine-clinopyroxene-phyric basalts; these latter magma types have not previously been found on the subaerial islands. The lavas are characterized by flat or weakly light rare earth element (LREE)-depleted abundance patterns relative to chondrites, reflecting a refractory nature of the volumetrically most significant magma source in the mantle wedge. About 35% of these volcanoes are associated with hydrothermal plumes. Sites of hydrothermal venting are commonly located at summit or intracaldera cones, and also near the base of caldera walls.

In the northeast of the Lau Basin are the Fonualei Rifts, extending south of the Mangatolu Triple Junction. A complete 30 kHz swathmap of these Rifts was obtained during the NoToVE voyage. Numerous particulate plumes were identified with vertical hydrocasts above a number of the rift axes, indicative of some major hydrothermal plume sources, and possible net contributors to the very large, ³He-rich hydrothermal plume identified at 1700m depth in the Lau Basin (Lupton et al., 2003). The striking feature of the Fonualei Rifts is the capture of the entire suprasubduction zone magmatic flux for a distance of about 150 km, shutting down the adjacent Tonga Arc volcanoes which are carbonate covered and degraded with no evidence of recent volcanic activity. Preliminary analyses of the samples recovered from the Fonualei Rifts show them to be arc-like basalts and andesites with flat or weakly LREE-depleted to slightly enriched abundance patterns relative to chondrites. The lavas are also extremely depleted in Na compared with the global backarc sample suite, probably reflecting both a highly refractory mantle source and relatively large percentages of melting of this source. The Fonualei Rifts lavas are a newly-recognised global backarc end-member with markedly low Na contents reflecting a highly refractory mantle wedge source coupled with high degrees of partial melting. The southern Rifts have captured the entire supra-subduction zone magma flux over

about 150 km of strike; adjacent Arc volcanoes are inactive and carbonate capped. Ongoing work involves the integration of the tectonic development, age dating and detailed petrologic studies of the igneous rocks.