Materials and Methods

Outcrop description. Coesite eclogite was discovered in the Tumagabuna Islands (9°29'0"S, 150°27'40"E), located offshore western Fergusson Island, and part of the D’Entrecasteaux Islands. Previous workers had described the mafic eclogites at this locality as xenoliths in granodiorite. Additional field observations were made in January 2008, on new outcrop formed by the damaging effects of a tsunami triggered by a magnitude 8.1 earthquake on April 1, 2007, in the Solomon Islands.

The garnet-bearing quartzo-feldspathic host gneisses are strongly foliated and isoclinally folded. Mafic eclogites appear to have originated as mafic dikes that were metamorphosed in situ at eclogite-facies conditions and now occur as eclogite boudins. The eclogite boudins have retrograde amphibolite rinds that are in turn encapsulated by pegmatite rinds. Pegmatite veins intrude the quartzo-feldspathic host and are locally concordant with the gneissic foliation. Foliation in the mafic eclogites is roughly concordant with that in the host gneiss. Overall, foliations dip south or southwest and have lineations that plunge down-dip. Shear sense is top-to-the-north based on the dragging of foliation into a south-dipping shear zone in the quartzo-feldspathic gneiss.

Raman spectroscopy. Raman analyses were performed on polished thin section (89321c) at the Cornell Center for Materials Research. Spectra were obtained with the Dilor XY 800 Raman system using the 514.532 nm excitation line of an argon-ion laser. Mostly polarized scattered light was collected in the back scattering mode by using the Raman microscope. Excitation energy at the location of the sample was 10 mW, the laser spot size was 5μm. Wavenumber calibration was performed by registering a neon spectrum, thereby confirming the accuracy of the measured frequencies to within 0.2 cm⁻¹. Cryogenically cooled CCD detector covered the spectrum from 165 cm⁻¹ to 865 cm⁻¹ and the size of the slits corresponded to the spectral resolution of 1.75 cm⁻¹. Frequencies (cm⁻¹) of coesite and quartz Raman bands are given in Table DR1.
**Electron probe.** Mineral compositions were determined from 27 garnet–pyroxene–phengite triplets on thin section 89321C. Data used for garnet–pyroxene–phengite barometry (Ravna and Terry, 2004), and garnet-pyroxene Fe$^{+2}$–Mg cation exchange thermometry (Ravna, 2000) were obtained on omphacite encapsulating the coesite relic and adjacent garnet and phengite by wavelength-dispersive X-ray analysis using a fully automated JEOL 733 electron microprobe at Victoria University of Wellington’s Analytical facility (http://www.victoria.ac.nz/geo/facilities/analytical/electron-microprobe.html). Operating conditions were 15 kV and 12 nA. Count times were 30 seconds for Si, Ti, Al, Fe, Mn, Mg, Ca, Na, and K. Background count times were 10 seconds. The oxidation state of iron in garnet is assumed to be Fe$^{+2}$, and Fe$^{+3}$ within pyroxene was estimated by assuming Fe$^{3+} = \text{Na} - (\text{Al} + \text{Cr})$, with Cr assumed to be zero (i.e., Cr was not analyzed). Garnet standard composition is 39.0% SiO$_2$, 0.08% TiO$_2$, 22.1% Al$_2$O$_3$, 22.03% FeO (total), 0.39% MnO, 11.53% MgO, 4.20% CaO.

Mineral compositions used for rutile thermometry were obtained using a fully automated Cameca SX-100 electron microprobe at the Rensselaer Polytechnic Institute (http://ees2.geo.rpi.edu/probe). Operating conditions were 15 kV and 20 nA. Rutile is ubiquitous in this coesite-eclogite, occurring as inclusions in garnet, pyroxene, and phengite, and also within a matrix of predominantly garnet, pyroxene and phengite. Analyses used for Zr thermometry were performed on both rutile inclusions and rutile in the matrix. Analytical uncertainty for rutile thermometry is <5°C (2σ) (see Fig. 6 in Watson et al., 2006). Mineral compositions are given in Tables DR2 and DR3.

**Ion Microprobe.** *In situ* ion microprobe analyses were conducted on the ims 1270 ion microprobe in the Department of Earth and Space Sciences at the University of California, Los Angeles. Samples were prepared by embedding portions of thin section 89321B within 1 inch-round epoxy mounts. Analytical conditions were 10 kV accelerating voltage, 1 nA primary beam current, and a spot size of ~10 μm. Mass resolution of ~5000 was sufficient to resolve masses of interest in this study. Secondary ion masses analyzed included $^{30}$Si, $^{45.5}$Zr$^{+2}$, $^{57}$Fe, and $^{49}$Ti. Concentrations were
derived relative to SL13 standard zircon with intensities on unknown and standard normalized to $^{45.5}\text{Zr}^{2+}$. Zircon grains selected for Ti analyses were the same as those analysed for their U-Pb, trace and REE compositions (Monteleone et al., 2007). Zircons were larger than the primary beam spot size (10 $\mu$m), and occur as inclusions in garnet. A combination of secondary ion imaging and the application of a field aperture were used to position the primary beam onto the zircon grain in order to avoid overlap with surrounding phases. Potential contamination from surrounding phases was monitored by measurement of $^{57}\text{Fe}$ and by assessment of $^{45.5}\text{Zr}^{30}\text{Si}$. Samples with increased $^{57}\text{Fe}$ intensities and/or decreased $^{45.5}\text{Zr}^{30}\text{Si}$ ratios were not used for zircon thermometry. [Ti] and [Zr] used for zircon and rutile thermometry are given in Table DR3.
# Supplemental Data

## Table DR1: Frequencies (cm⁻¹) of coesite and quartz Raman bands of bimineralic samples

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*from Liu et al., 1997
Table DR2: Mineral Compositions

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* garnet reference standard analyses

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**Table 1. Chemical Composition of Analyses**

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<td>Na$_2$O</td>
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<td>0.73 ± 0.01</td>
<td>0.64 ± 0.01</td>
<td>1.02 ± 0.01</td>
<td>1.14 ± 0.02</td>
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</tr>
<tr>
<td>K$_2$O</td>
<td>9.91 ± 0.15</td>
<td>9.52 ± 0.15</td>
<td>9.51 ± 0.15</td>
<td>9.23 ± 0.14</td>
<td>8.84 ± 0.14</td>
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</tr>
<tr>
<td>Total</td>
<td>93.92</td>
<td>93.81</td>
<td>94.65</td>
<td>95.11</td>
<td>94.19</td>
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</tbody>
</table>

Note: Fe$^{3+}$ within pyroxene was estimated by assuming Fe$^{3+}$ = Na–(Al + Cr), with Cr assumed to be zero (i.e., Cr was not analyzed).
Table DR3: Rutile and Zircon Thermometry

<table>
<thead>
<tr>
<th>Phase</th>
<th>Analysis</th>
<th>Ti (ppm)</th>
<th>Zr (ppm)</th>
<th>T(°C)</th>
<th>T (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rt</td>
<td>1 (i)</td>
<td>240.8</td>
<td></td>
<td>709</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>2 (i)</td>
<td>239.3</td>
<td></td>
<td>708</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>2_2 (i)</td>
<td>204.8</td>
<td></td>
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<tr>
<td>Rt</td>
<td>3_1 (m)</td>
<td>303.1</td>
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<td>729</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>3_2 (m)</td>
<td>271.2</td>
<td></td>
<td>719</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>4_1 (m)</td>
<td>285.0</td>
<td></td>
<td>723</td>
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</tr>
<tr>
<td>Rt</td>
<td>4_2 (m)</td>
<td>250.1</td>
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<td>712</td>
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</tr>
<tr>
<td>Rt</td>
<td>4_3 (m)</td>
<td>281.2</td>
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<td>722</td>
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</tr>
<tr>
<td>Rt</td>
<td>5_1 (*)</td>
<td>290.4</td>
<td></td>
<td>725</td>
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</tr>
<tr>
<td>Rt</td>
<td>5_2 (*)</td>
<td>234.4</td>
<td></td>
<td>706</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>7_1 (i)</td>
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<td>705</td>
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</tr>
<tr>
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<tr>
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</tr>
<tr>
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<td>10_1 (m)</td>
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<td>701</td>
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</tr>
<tr>
<td>Rt</td>
<td>10_2 (m)</td>
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<td>704</td>
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<tr>
<td>Rt</td>
<td>10_3 (m)</td>
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</tr>
<tr>
<td>Rt</td>
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<td>743</td>
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<tr>
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<td>727</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Rt</td>
<td>14_1 (*)</td>
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<td></td>
<td>710</td>
<td></td>
</tr>
<tr>
<td>Rt</td>
<td>15_1 (*)</td>
<td>226.5</td>
<td></td>
<td>704</td>
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</tr>
<tr>
<td>Rt</td>
<td>16_1 (*)</td>
<td>245.3</td>
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<tr>
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</tr>
<tr>
<td>Zr</td>
<td>3.4 (i)</td>
<td>3.7</td>
<td></td>
<td>660</td>
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</tr>
<tr>
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<td>4.1 (i)</td>
<td>3.2</td>
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<td>650</td>
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<tr>
<td>Zr</td>
<td>4.2 (i)</td>
<td>4.5</td>
<td></td>
<td>675</td>
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</tr>
</tbody>
</table>

Note: (i) indicates grain is inclusion in garnet. (m) indicates grain is not an inclusion in garnet (matrix). (*) indicates location of grain not known due to loss of photo file data. Rutile grain size for inclusion grains is approximately 30 – 80 microns. Matrix rutile is approximately 200 – 400 microns. Zircon inclusions are ~20 – 30 microns.


