Spatial Expansion of Aftershock Zones with Time: Examples from the Vanuatu (New Hebrides) Island Arc

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Three large (Ms=6-7), interplate earthquakes in the Vanuatu (New Hebrides) island arc had aftershock zones which expanded remarkably in area over a two week period of time. The aftershocks were well-located by the Cornell/ORSTOM seismograph network which has been monitoring earthquakes larger than m_b=3.0 since mid-1978. For each event the aftershocks in the first few hours define an area which is consistent with the rupture zone for an earthquake with the observed seismic moment. However, during the weeks following each mainshock, the area of the aftershock zone increased 5 to 13 times the area of the inferred rupture. These observations indicate that caution must be used in determining the extent of plate boundary rupture from aftershocks. The growth of the area (A) for each aftershock zone as a function of time (t) is best described by a function of the form $A(t) = A_0 \ln(kt+1)$. The areal growth function has the same form as the cumulative version of Omori's law which describes the growth of the number of aftershocks with time. The characteristic time associated with the growth of each aftershock zone is much longer than the time of rupture propagation, but it is much shorter than the viscoelastic time constants associated with tectonic loading and asthenosphere relaxation. Expansion of the aftershock zone may represent failure of asperities due to the migration of stress away from the region of coseismic slip.

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