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SPATIAL AND TEMPORAL SEISMIC ENERGY RELEASE IN THE EFATE REGION (CENTRAL NEW HEBRIDES ISLAND ARC) : EVIDENCE FOR BUCKLING ?

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Abstract. A study of the spatial and temporal distributions of the seismicity in the central New Hebrides island arc shows that the Efate region (including the interplate boundary and the upper plate) can be considered as a single block under

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is the seismicity of the Efate segment, the zone covered by the network has been divided in 3 regions, which for convenience we call the Efate region, the northern region, and the southern region without further distinction of blocks north

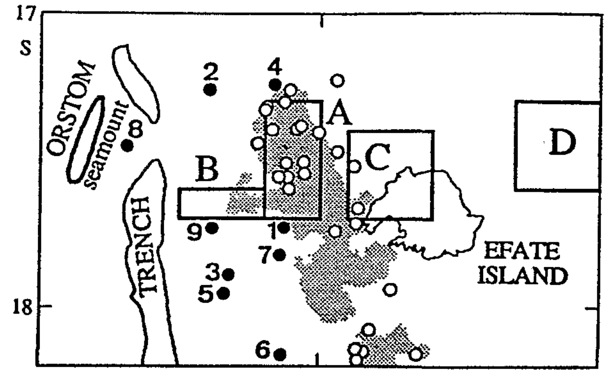

Fig. 2. Map of the Efate region, as defined in this study. The shaded area represents the down-dip zone with high background seismicity level. Boxes represent the four cluster zones from Chatelain et al. [1986]. ORSTOM seamount and trench contours as in Figure 1. The magnitude (M_S, mb) > 5.0 main shocks that occurred during the period 1978-1990 are shown by open circles in the down-dip zone, and by solid circles numbered by chronological order in the up-dip zone. Magnitudes of up-dip main shocks: 6.2 (1); 7.1 (2); 5.1 (3); 6.7 (4); 5.6 (5); 6.3 (6); 5.1 (7); 5.1 (8); 6.2 (9).

October 1978 to 1984, Chatelain et al. [1986] have shown that most of the seismicity is concentrated in the Efate region and that two regimes of seismicity characterize the Efate region. Next to the trench (termed the up-dip part of the contact zone), the background seismicity level is low, and main shocks (magnitude Ms, mb > 5.0) are followed by large aftershock zones. Nearer to the island arc (termed the down-dip part of the contact zone), the background level is very

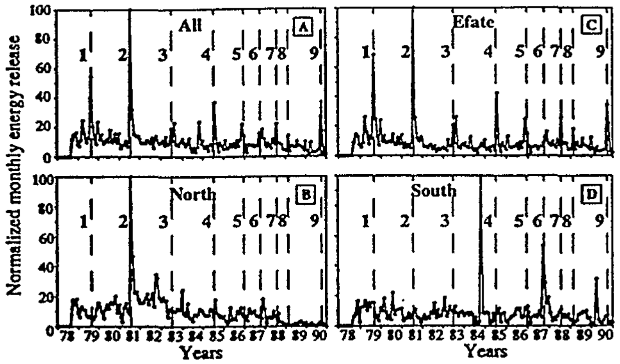

Fig. 3. Monthly energy release in the regions delimited in Figure 1: (A) entire region, (B) northern region, (C) Efate region, and (D) southern region. Occurrences of up-dip magnitude (M_S, mb) > 5.0 main shocks are shown by dotted numbered lines. Numbering for main shocks as in Figure 2. Energy has been calculated with the formula Log(E) = 11.4 + 1.5*M. For each month the summation of Log(E) is represented rather than summation of E, in order to avoid squeezing of the scale by the highest peaks. For each region, the energy release has been normalized to the highest peak of the given region. Energy values for the highest peaks are (in ergs) : 1.20 10 **22, 5.64 10**21, 1.17 10**22 and 8.00 10**21 for the entire, northern, Efate and southern regions respectively.

distinct zones : up-dip, down-dip, and zones A,B,C,D. Whereas zones A and B overlap the up-dip and down-dip zones, zones C and D are totally separate (Figure 2). Peaks in energy release in these 6 zones are closely related within a few month time lag. Moreover, energy release in the different zones are correlated in time with magnitude (Ms, mb) > 5.0

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events located in the up-dip zone (Figure 4), but no correlation is apparent with the magnitude (Ms, mb) > 5.0 events that occur in the down-dip zone. No consistent cycle appears in the spatial distribution of energy release. The delay between energy release in the different zones is also variable from almost instantaneously to few months before and/or after the up-dip main shock occurrences (Figure 4). Thus, the activity in none of the 6 zones appears to control the triggering of seismic activity in the others, and no reproducible seismic migration can be observed. Rather, the Efate region (comprising the contact zone between the two plates and the upper plate east to zone D) behaves like a single entity under stress.

Discussion and Conclusion

Kanamori [1971] suggested that the great and apparently systematic variations in the size of large interplate earthquakes from one subduction zone to another correlates with the degree of compression across the plate boundary. Different idealized subduction types have been proposed according to their seismic coupling efficiency as estimated by the maximum earthquake size [Ruff and Kanamori, 1980] or by summing seismic moments [Petterson and Seno, 1984]. Thus, variations in seismic coupling along arcs can be related to variations in the mean normal stress that act across the subduction zone plate interfaces. At a smaller scale, in comparing arcs with different seismic coupling, Lay and Kanamori [1981] assumed that stresses are inhomogeneously

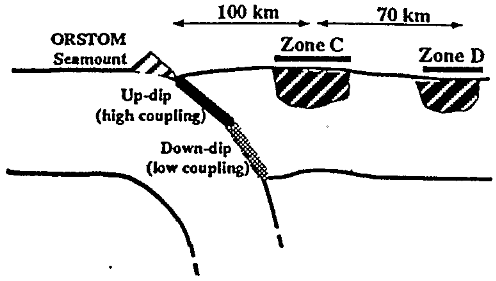

Fig. 5. Schematic cross section of the Efate block. In the up-dip part of the interplate boundary the subduction process is perturbated by the arrival of the ORSTOM seamount. As a consequence, the Efate region behaves like a single mechanical entity, leading to buckling process in the upper plate with repeated activation of weak zones in the upper plate linked to episodes of main energy release along the up-dip part of the interplate boundary.

km) is bounded by major events locations, background seismicity level, and aftershocks migration.

The localization of the clustered activity in front of the most strongly coupled area (Figure 5), is induced by high stress in this zone, despite the fact that it is usually assumed that in subduction zones, earthquakes are result of slip instabilities that depend on the contrasting stiffnesses of the fault and the coupled plate system [e.g. Stuart and Mavko, 1979; Li and

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