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Earthquake distributions and their relationship with structural, chemical and thermobaric heterogeneities in subducting slabs

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The subduction of oceanic plates is usually accompanied by zones of intense but heterogeneous seismicity in the descending slab. The non-uniform distribution of earthquakes within Wadati-Benioff zones may be controlled by several factors. Ambient stress, strain rate, temperature, pressure, and structural and chemical heterogeneities may all play roles in determining the locations of earthquakes within subducting slabs.

Gradual variations in seismic activity on the scale of subduction zones are likely to be controlled by temperature, pressure, stress and/or strain rate. This is most clearly illustrated by earthquake depth distributions. While young slowly subducting plates have only shallow and intermediate seismicity, old rapidly subducting plates are often seismically active to depths greater than 300 km. The dependence of seismic activity on temperature implied by this observation is studied in more detail with thermokinematic models. Deep focus earthquake activity within several Wadati-Benioff zones is consistent with most activity occurring within a narrow band of P-T space.

On a smaller scale, earthquake hypocenters cluster into nests, streaks and bands separated by regions with lower levels of seismic activity. Such features in the seismicity are unlikely to a result of thermobaric variations; another cause is required. Streaks of intermediate and deep focus earthquakes within several subduction zones have orientations similar to those expected of faults created at the surface and then subducted. Despite this, focal mechanisms are generally incompatible with reactivation. The clustering of earthquakes along such streaks may be controlled by grain size reduction or hydration of the shallow mantle.