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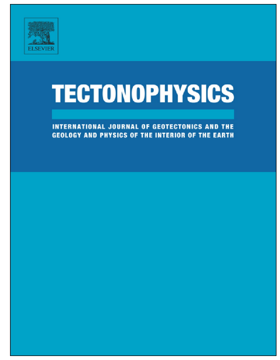

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Multivariate statistical analysis to investigate the subduction zone parameters favoring the occurrence of giant megathrust earthquakes

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Abstract

The observed maximum magnitude of subduction megathrust earthquakes is highly variable worldwide. One key question is which conditions, if any, favor the occurrence of giant earthquakes ($M_w \geq 8.5$). Here we carry out a multivariate statistical study in order to investigate the factors affecting the maximum magnitude of subduction megathrust earthquakes. We find that the trench-parallel extent of subduction zones and the thickness of trench sediments provide the largest discriminating capability between subduction zones that have experienced giant earthquakes and those having significantly lower maximum magnitude. Monte Carlo simulations show that the observed spatial distribution of giant earthquakes cannot be explained by pure chance to a statistically significant level. We suggest that the combination of a long subduction zone with thick trench sediments likely promotes a great lateral rupture propagation, characteristic for almost all giant earthquakes.

Keywords

Giant megathrust earthquakes; maximum magnitude; multivariate statistics; subduction megathrust seismicity; pattern recognition.

1. Introduction

Subduction megathrusts (i.e., large faults between the subducting and overriding plate) produce the Earth's greatest earthquakes, also known as giant earthquakes GEqs (i.e., $M_w \geq 8.5$). Consequently, they account for the majority of seismic energy globally released during the last century *(Pacheco and Sykes*, 1992). As recently demonstrated by the 2004 Sumatra-Andaman ($M_w = 9.2$) and 2011 Tohoku-Oki earthquakes ($M_w = 9.1$), these events are major threats to society and their occurrence