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Cyclic volcanism at convergent margins: Linked to Earth Orbital Parameters or Climate Changes?

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The frequency of volcanic activity varies on a wide range of spatial and temporal scales, from <1 yr. periodicities in single volcanic systems to periodicities of 106 yrs. in global volcanism. The causes of these periodicities are poorly understood although the long-term global variations are likely linked to plate-tectonic processes. Here we present evidence for temporal changes in eruption frequencies at an intermediate time scale (104 yrs.) using the Pleistocene to recent records of widespread tephras of sub-Plinian to Plinian, and occasionally co-ignimbrite origin, along the Pacific Ring of Fire, which accounts for about half of the global length of 44,000 km of active subduction. Eruptions at arc volcanoes tend to be highly explosive and the well-preserved tephra records from the ocean floor can be assumed to be representative of how eruption frequencies varied with time. Volcanic activity along the Pacific Ring of Fire evolved through alternating phases of high and low frequency; although there is modulation by local and regional geologic conditions, these variations have a statistically significant periodicity of 43 ka that overlaps with the temporal variation in the obliquity of the Earth's rotation axis, an orbital parameter that also exerts a strong control on global climate changes. This may suggest that the frequency of volcanic activity is controlled by effects of global climate changes. However, the strongest physical effects of climate change occur at 100 ka periods which are not seen in the volcanic record. We therefore propose that the frequency of volcanic activity is directly influenced by minute changes in the tidal forces induced by the varying obliquity resulting in long-period gravitational disturbances acting on the upper mantle.