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Use of strain rate data to determine the probable return period of characteristic earthquakes

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The mean value of the strain rates determined with strainmeters worldwide is Ĩ0-6•year-1. From geodetic studies of the strain it can be concluded that regional annual rate values are of the order of 10-8. The reason of this difference lies partly in local behaviour of strainmeter observations, in local disturbances on the instruments (topography and cavity effects, instrumental drift etc.) but the theoretical background of the problem is not clarified yet. On the other hand the geodetic strain rates - valid for regional observations - not allow their use in local scale to estimate the necessary stress accumulation time for characteristic earthquakes. The strain rate derived from seismological observations - according to Kostrov equation - can be related to the sum of the seismic moment tensors of the earthquakes occurring in a volume at a single fault during a time-interval. There are different possibilities to estimate the volume of the seismic source (e.g. from the spatial distribution of aftershocks). The sum of seismic moment tensors in most cases depends practically on the single moment tensor which belongs to the characteristic event of the seismic source in question. If arbitrarily for the return period 250 year is taken the seismic strain rate values obtained for the greatest known earthquakes ($MW \geq 9.0$) are 10-6-10-7. Seismic strain rates of significant ($6.5 \leq MW \leq 7.5$) and medium ($5.5 \leq MW \leq 4.5$) earthquakes are 10-5-10-6. Due to the fact that the strain rates are inversely dependent on return period it can be supposed that the time-interval between characteristic earthquakes in case of seismic sources producing the greatest seismic events ($MW \geq 9.0$) is 10-100 time longer than in case of tectonic units producing significant and medium size seismic events.
The time-interval between the characteristic earthquakes of a seismic zone can be estimated on the basis of accurate geodetic observations of deformation carried out in the surroundings of an active source zone with the use of Kostrov's equation. For this purpose however in case of GPS measurements 10-8 relative accuracy (or even better) is needed on a base spanning 30-40 km, what is not achieved at present. The regional strain rate data based on methods of space geodesy should be used for this purpose very carefully because they have a basis of the order of 102 km. In case of strainmeter observations this accuracy is warranted on the base less then 100 m, but the strain rate values of these records are suffering because of local and instrumental influences.