# The State of Stress in the Earth's Lithosphere

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## Abstract

The state and the magnitude of stress in the Earth's lithosphere have an important bearing on various geophysical problems such as the plate driving mechanism, the energy budget of the Earth, earthquake mechanisms and crustal movements. Classical studies on this subject include the work of Jeffreys [1], who showed that stress differences of at least 1.5 kbar exist within the outermost 50 km of the crust underneath high mountains such as the Himalayas. It is important to note that this conclusion does not depend upon whether the mountains are supported elastically or nonelastically. As long as a surface relief is maintained for a finite geological time (e.g., several million years), a stress difference comparable to its load must exist. On the other hand, studies of crustal deformations associated with large earthquakes indicated a much smaller value, about 100 bar or less for the change in the stress associated with earthquakes. TSUBOI [2] found that the maximum strain change associated with large earthquakes is about 2 to 3·10^(-4) and concluded that the Earth's crust cannot sustain a strain exceeding this value. Since the rigidity of crustal rocks is about 3·10^5 bar, this result suggests that the strength of the Earth's crust is about 60 to 90 bar. Although TSUBOI interpreted this value as the ultimate strength of the rock, it actually represents the change in the stress (stress drop) before and after the earthquake, and, therefore, provides the lower bound of the strength. Thus this large difference between the two estimates (1.5 kbar vs. 100 bar) does not necessarily pose a serious problem if a very small fraction of the tectonic stress is released in earthquakes. Nevertheless, this order-of-magnitude difference has been a matter of considerable debate among geophysicists. More recent results from in situ stress measurements, analysis of deformation of the lithosphere at trenches and seamounts and laboratory experiments on rocks provided estimates of stresses in the lithosphere ranging from 10 bar to 10 kbar. It is as yet unclear how these results from different measurements can be synthesized into a consistent model of the state of stress in the lithosphere. In this paper, we review the current knowledge on this subject with special emphasis on seismological studies, and will discuss several possible models.

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