CRITICALITY OF SUBDUCTING SLABS

RIEDEL, M. R., KARATO, S., and YUEN, D. A. 1GeoForschungsZentrum, Potsdam, Germany2Univ. of Minnesota, Minneapolis, USA

We calculate the amount of viscousdissipation during subduction of alithospheric plate as constrained byexperimental rock mechanics.\\The maximum bending moment M_{crit}that can be sustained by a slab is ofthe order of 10^{19} Nm per maccording to $M_{crit} \cong \sigma_p *h^2/4$, where σ_p is the Peierl'sstress limit of olivine and h is theslab thickness.\\Near M_{crit}, the amount of viscousdissipation grows strongly as aconsequence of a lattice instability ofmantle minerals (dislocation glide inolivine). The value of M_{crit} isabout 1-2 orders of magnitude too highto be reached by a ridge push oftypically 10^{12} N per m atconvergent plate boundaries, but unusualtectonic settings like a thicksedimentary load of the lithosphereor a shallow angle of slab penetrationat the transition zone can help tooverstep this bending momentthreshold.\\The immediate consequence is a suddendrop of the effective viscosity to below10^{21} Pas, so that the observedweakening effect serves as aself-regulating mechanism to adjustplate tectonics on Earth against strongviscous resistance forces.