LOCAL EFFECTS ON EARTH TIDE OBSERVATIONS

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(Delivered in absentia by Prof. Melchior)

Cavity, topographic and geologic effects have similar influences on the observed tidal variations of tilt and strain. They cause the locally observed tilts and strains to differ from the "true" or regional values.

The locally observed strain is a linear combination of the components of the regional strain tensor. Very large perturbations are possible; for example a 60 times strain magnification has been observed across a narrow, high cavity in the Black Forest Earth Tide Observatory. The locally observed tilt is a combination of regional tilt plus a local strain-induced tilt. Any observed earth tide tilt or strain will be contaminated by these effects. The gross scale topographic and geologic effects can be computed fairly successfully; the small scale effects are difficult to compute owing to the impossibility of modeling the geometrical and material irregularities of the cavity.

For the purpose of this conference, the interest in earth tides is centered on the anomalous tides to be expected as a result of the nearly diurnal wobble, and the question of interest is how these effects influence the tidal spectrum. The coupling coefficients themselves are independent of frequency. For solid earth tides arising from potential terms of a given order and degree, these effects therefore will influence the response at each tidal frequency by the same amount. The only frequency dependence arises from the ocean load contributions. However, the cavity and topographic influences will be different for tides of different species and for tides arising from the second and third harmonics of potential, not because the coupling coefficients themselves are frequency dependent but because the geometrical configuration of the strain tensor is different. However, the P_3 tides in the vicinity of the resonance with the nearly diurnal wobble are small, and their response is expected to be very different from the P_2 tides for other reasons. The influence of the topographic, cavity and geologic effects is therefore not an important one as far as detecting the wobble resonance.

E. P. Fedorov, M. L. Smith and P. L. Bender (eds.), Nutation and the Earth's Rotation, 203–204.

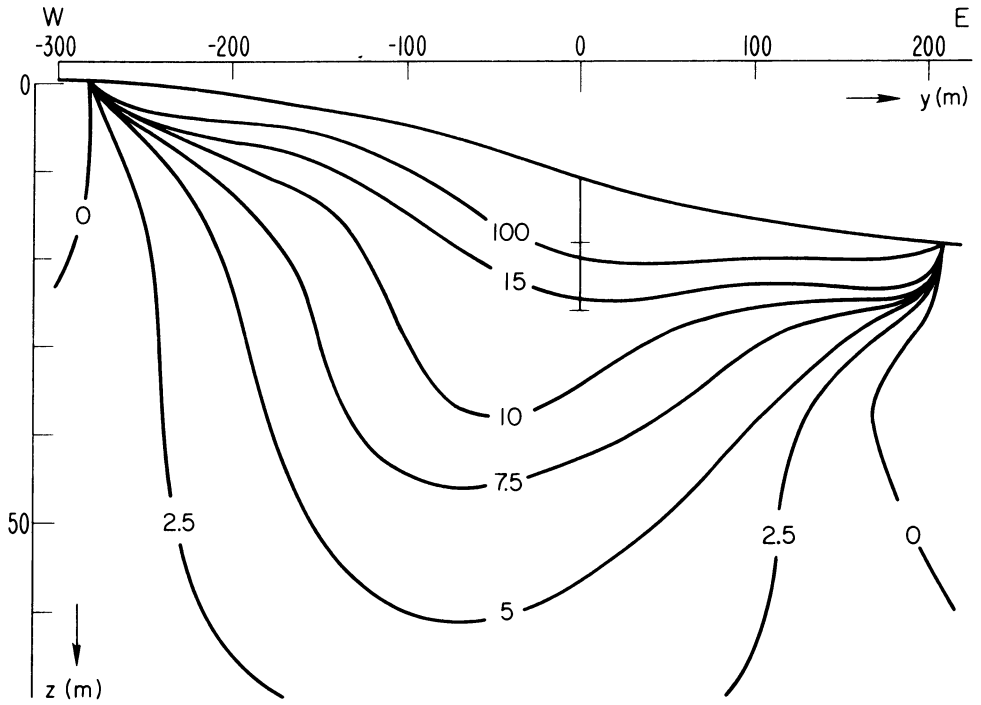

Figure 1

Thermoelastic effects will influence the spectrum at daily periods owing to the daily solar heating cycle. These effects have been misunderstood in the past because they have been analyzed for a semi-infinite half space. In fact the important interaction is between the stresses generated by the heated surface of the rock and the topography (Harrison and Herbst, 1977). These effects can be calculated by finite element techniques. Figure 1 shows annual tilts computed for the Zellerfeld station of the Clausthal Institute of Geophysics by Klaus Herbst of that Institute. The calculations for boreholes of 15 and 30 meters depth are in very good agreement with the observed annual tilts. Thus thermoelastic influences on observed tilt and strain may be very different from those expected on existing half-space theories.

Reference

Harrison, J. C. and Herbst, K.: 1977, Geophys. Res. Letters 4, 535-537.