STUDY ON THE EARTH CONSTANTS IN THE CENTRAL NORTH AMERICAN CONTINENT

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A Digest Presented to the Faculty of the Graduate School
of Saint Louis University in Partial Fulfillment of
the Requirements for the Degree of
Doctor of Philosophy

1977

DIGEST

Since the beginning of this century interest in studies on the earth tides has centered on the observation of the Love numbers as a measure of the elastic properties of the solid earth. Due to environmental disturbances and instrumental limitations, no unanimous agreement on values for those numbers has yet been reached. Among the disturbing influences, the ocean tide loading effect is considered to be of the most importance and its correction has been emphasized in recent years.

In order to minimize, or to avoid altogether if possible, the effect of ocean loading, the tidal strain was observed at Flat River, Missouri, a site in the interior of the North American Continent, by an array of 3-component quartz-rod extensometers. In terms of five modes of data analysis, the results obtained are 1) that the observed Love numbers are frequency-dependent and should be regarded as apparent numbers of local meaning, and 2) that anomalous phase shifts found in the analysis are such that they can hardly be removed by applying the ocean tide loading corrections.

The Love numbers are dimensionless indices.

Hooke's law may be expressed in three dimensional

form as $\bar{F} = [K] \bar{x}$. In this expression the 3 x 3 matrix $[K]$ is defined as the stiffness matrix of the earth's continuum. The value of $[K]$ can be synthesized mathematically as a function of the Lamé constants λ and μ as well as of the density distribution within the earth. Once the value of $[K]$ is known, both the Love number h and the Shida number ℓ can be easily obtained from its diagonal elements. The off-diagonal elements of $[K]$ would contribute to a transverse contraction phenomenon in the solid elastic continuum; a non-hydraulicity index is therefore introduced. For a mass as large as the real earth, the self-gravitational forces predominate over the molecular forces, so that the non-hydraulicity index is very close to zero. This means that the solid earth behaves like a mass in hydrostatic equilibrium. Hence, the off-diagonal elements of the stiffness matrix are negligible.

In an attempt to remove the phase shift in our observations, causes other than the ocean tide loading disturbances, such as the ellipticity of the earth, the cavity effect in the tunnel and the tilting of the ground rock near the observatory, etc. have also been studied. It is found that while all the other causes are but minor, the tilt of the local ground surface, which is equivalent to a topographic correction, plays an important role in distorting the tidal strain field. This suggests a reason for the diversity in the values of the Love numbers as observed around the world.

According to Hooke's law, two elastic parameters λ and μ, the Lamé constants, are sufficient to specify the stress-strain characteristics at each point within a homogeneous, isotropic medium. Based on an observed value of μ close to that of iron, the earth is generally accepted as a very rigid body. This is actually a microscopic point of view regarding the material of the earth. However, in observing the earth tides, we are measuring the rise and fall of the earth surface with respect to the earth's center. In view of the structure of the earth, this accumulated displacement is a function of the stiffness of the earth. Macroscopically, the earth acts equivalently as a spring of large dimension possessed of a weak spring constant k such that it deforms quite easily in response to the tidal generating force. In this regard, it might be viewed as a soft ball. Or, to change the image, the earth reacts as a huge invertebrate made of very rigid materials -- A reason for the occurence of earth tides.