

Postdeadline Abstracts

Geodesy

G10A

GRAVITATIONAL POTENTIAL ENERGY OF THE EARTH: A SPHERICAL HARMONIC APPROACH

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A spherical harmonic equation for the gravitational potential energy of the earth is derived for an arbitrary density distribution by conceptually bringing in mass elements from infinity and building up the earth shell upon spherical shell. The zeroth degree term in the spherical harmonic equation agrees with the usual expression for the energy of radial density distribution. The second degree terms give a maximum nonhydrostatic energy in the mantle and crust of -2.77×10^{29} ergs, on order of magnitude below McKenzie's (1966) estimate. This figure is almost identical with Kaula's (1963) estimate of the minimum shear strain energy in the mantle, a not unexpected result on the basis of the Virial theorem. If the earth is assumed to be a homogeneous viscous oblate spheroid relaxing to an equilibrium shape, then a lower limit to the mantle viscosity of 1.3×10^{20} poises is found by assuming the total geothermal flux is due to viscous dissipation. This number is almost six orders of magnitude below MacDonald's (1966) estimate of the viscosity and removes his objection to convection. If the nonequilibrium figure is dynamically maintained by the earth acting as a heat engine at one per cent efficiency, then the viscosity is 10 poises, a number preferred by some (e.g., Cathies (1975)) as the viscosity of the mantle.

G36A

RESULTS OF DRY TILT MEASUREMENTS FOR 1977, PALMDALE UPLIFT, CALIFORNIA

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Twenty-seven telescopic spirit leveling (dry tilt) arrays have been established throughout the initially recognized Palmdale uplift area since October, 1976, to document the nature of regional crustal tilt. Resurveys are done monthly to a precision of 2-4 μ rad. Observation periods of individual arrays vary from 3 to 10 months, depending on dates of installation and attainment of site stability.

As of October, 1977, tilt trajectories point west and northwest in the Mojave structural block northeast of the San Andreas fault; a radial pattern of tilt trajectories is apparent in the San Gabriel Mountains block, radiating outward from a point about 15 km WSW of Palmdale; and tilt trajectories in the Los Angeles block, south of the San Gabriel Mountains frontal faults show no consistent pattern.

Although the dry tilt data reflect the geometry of the Palmdale uplift, they may record only secular seasonal tilt during the observation period rather than tectonic crustal movements.

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TECHNIQUES FOR INTERPRETATION OF GEIOD ANOMALIES

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With the abundance of geoid data from the GEOS-3 satellite, it is necessary to understand how to utilize such measurements. For the study of the interior of the Earth, thus we have developed a variety of techniques for direct interpretation of geoid anomalies. On a two-dimensional plane earth for a given polygonal density distribution an exact line integral method can be used to compute the resultant geoid anomaly. Likewise on a three dimensional

plane earth for a polygonal body an exact surface integral expression will compute the geoid anomaly.

A better understanding of the relation between gravity and geoid may be obtained in the frequency domain. Given the Fourier transform of the gravity one obtains the transformed geoid by multiplication with a transfer function. This shows that the geoid is related to gravity by a suppression of high frequencies and amplification of low frequency components. With this transfer function then it is possible to compute geoid anomalies on two and three dimensional plane earths via FFT methods. Utilizing a linearization of these FFT methods and models of compensation the admittance may be calculated between bathymetry and the geoid. Applications of these techniques are used to show the utility and limitations of the formulae.

HORIZONTAL DISPLACEMENTS IN THE EARTH'S CRUST IN THE VICINITY OF EL CENTRO, CALIFORNIA

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The high precision Transcontinental Traverse along the U.S.-Mexico boundary (1975) includes ten stations belonging to the survey of 1941. The 34 year time elapse between these surveys allows for the computation of actual displacement at the ten common stations. In view of the fact that the Transcontinental Traverse is precisely azimuth controlled, the magnitude of the movement vectors is considered to be very reliable. At triangulation station SMUGGLER 1935, a maximum displacement of 3.764 m is computed, translating into a rate of 0.111 ml per year.

SALTON SEA WATER-LEVEL RECORDS (1952-1977) AND THE SOUTHERN CALIFORNIA UPLIFT

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Monthly records of water levels of the Salt Sea yield a unique temporal record of regional tilting associated with active vertical tectonics in the area of the southern California uplift. Differenced tide-staff readings from stations spaced 38 km on the southwest shore show a relatively steady tilt (down to the southeast) of 0.13 μ rad/yr from the beginning of record in 1952 to 1967. From 1967 to 1971 tilt in this direction accelerated to a rate of 0.46 μ rad/yr and then reversed direction. Total change in water-level difference was 90 mm until the time of tilt reversal. From winter 1971 to 1977 tilt has been down to the northwest at a rate of about 0.4 μ rad/yr. Both timing and magnitude of tilt agree remarkably well with the geodetic leveling data defining vertical crustal deformation associated with the southern California uplift in this region.

These water-level records provide independent confirmation of the leveling data as well as providing a continuous record of tectonic tilting. Monitoring of water levels at opposite ends of large lakes and reservoirs is relatively simple and may provide the best available record of the time scale of vertical deformation in tectonically active areas.

Geomagnetism and Paleomagnetism

GP7A

RADIOMETRIC DATES ON THE REVERSAL TIME SCALE BACK TO 13 MILLION YEARS AGO

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The magnetic field reversal time scale has not been well dated. Radiometric ages tie the time scale down since 3.32 m.y. Data from Gubbio, Italy, tie the beginning of anomaly 29 to the Cretaceous-Tertiary boundary, and thus indirectly to an absolute age of 65 m.y. In between these dates linear interpolation has been used to derive the reversal time scale. Data from Icelandic lava flows allow us to obtain radiometric ages for magnetic reversals back to 13 m.y. The extreme regularity of extrusion of Icelandic lava flows, and the large number of flows extruded per million years (about 70) has allowed the identification of groups of lava flows which were extruded during well recognized polarity sequences seen in marine magnetic anomaly records. Since dates are available for many of these lava flows (56 in all), it is possible to compare radiometric ages with "magnetic anomaly ages" in order to see if any discrepancy exists in the dating of the marine magnetic anomalies. Such a discrepancy exists, and can be used to correct the reversal time scale back to 13 m.y. ago. We find that the age of anomaly 5 is about 0.16 m.y. different than that given in a recently published time scale based on interpolation between 3.32 and 65 m.y.

A NEW APPROACH TO APPARENT POLAR WANDER PATHS

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Since their conception more than 20 years ago, apparent polar wander paths (APWP's) have become a very useful tool to geophysicists. This is particularly so for studies involving the more recent geological eras, although there is presently much debate concerning interpretations of paleomagnetic data from Palaeozoic and Precambrian rock formations. The problem is of course related to polyphase magnetizations that are carried by these rocks but the real difficulty in dealing with the data comes from the fact that the relative ages of these magnetisations are not always unequivocal. The problem is further compounded by the sparsity of reliable data.

The 'minimum distance' convention has been abandoned in favour of an approach which invokes 'maximum symmetry'. A reappraisal of Palaeozoic data from Gondwanaland reveals that there is a significant improvement in the interpretation of this data accompanied by an increase in the symmetry of the APWP. Extending this procedure further, a similar pattern can be recognised in the Precambrian data, mainly from North America. The significance of cyclical (recurring) asymmetric APWP's is not immediately apparent but if real, then they must surely reflect fundamental behaviour of the crust.

GP17A

MAGNETIC PROPERTIES OF SEDIMENTS FROM DSDP HOLES 166, 167, 317A, and 253

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In addition to the usual paleomagnetic measurements of NRM and remanent magnetization several rock magnetic measurements have been made on selected samples from DSDP Pacific Holes 166, 167, 317A and Indian Ocean Hole 253. The measurements made are: hysteresis and AR demagnetization of ARM and SIRM. Saturation of magnetization versus temperature (J_s-T) was possible only on volcanoclastic sediments from Holes 253 and 317A. A sufficient enough concentration of magnetic material was not obtainable from the carbonate or siliceous sediment in order to make J_s-T measurements. The following parameters have been calculated: MDF, H_{RC} , H_C , H_{RC}/H_C , and J_R/J_s . Hole 166 shows a decrease with depth of H_{RC} and H_C of about 100 and 30 Oe respectively with no apparent correlation with sediment type. In Hole 167 both H_{RC} and H_C drop suddenly in the middle of the core Cretaceous section by 100 and 15 Oe respectively without change in sediment type. Hole 317A shows an increase in