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Stress Differences and the Reference Ellipsoid

In a recent communication, Hulley (*1*) has connected gravity anomalies with other geophysical phenomena including faults and the pole positions. Unfortunately, the latter suggestion is not substantiated mathematically; for areas of any extent and for realistic rheology the *polfluchtkraft* can even be in the direction opposite that shown in Hulley's diagram (*2*). In this work, Hulley made use of diagrams of the contours of the geoid supplied by Kaula (*3*). The geoid contours to which Hulley refers do not give a clear picture of the distribution of the stress differences. This is because the reference ellipsoid is an approximation to the average ellipsoid. Stress differences, however, arise from the difference between the actual form of the earth and the theoretical one for fluid equilibrium. The flattening which corresponds to fluid equilibrium is approximately 1/300 as was pointed out by Henriksen (*4*) and later discussed by O'Keefe (*5*) and Munk and MacDonald (*6*). If we plot the values of the gravity anomalies referred to an ellipsoid with a flattening of 1/300, we get the result as shown in Fig. 1, which is based on Kaula's work. In comparison with Hulley's paper, Fig. 1 indicates that there may be a relation between the tectonic activity and gravity anomalies; at least the strong positive anomalies in the East Indian area appear to correspond with the maximum tectonic activity.

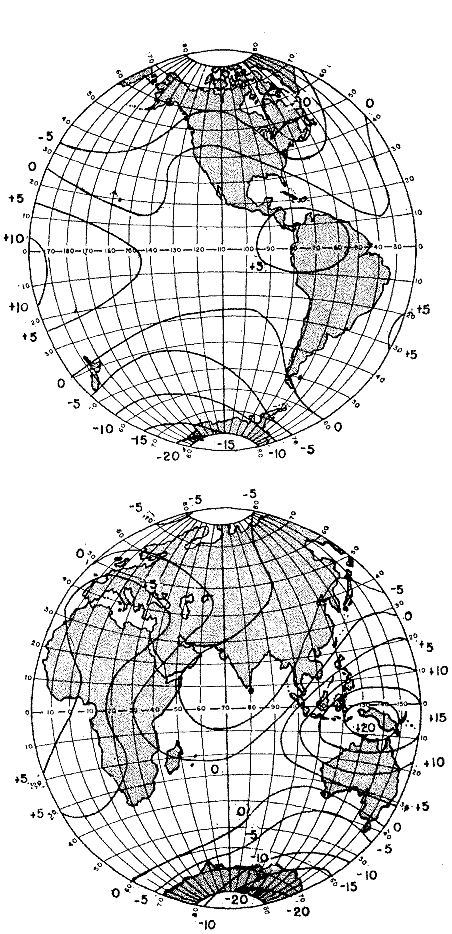

Fig. 1. Gravity anomalies, in milligals, derived from satellite perturbations and referred to an ellipsoid with a flattening of 1/299.8.

On the other hand, it should also be pointed out that there is a special explanation associated with the largest part of the discrepancy between the actual and equilibrium figures: the difference in oblateness can be considered as a lag of 10^7 years in adjustment to the slowing of the earth's rotation (*6*). So it is not entirely clear what the proper reference figure should be.

It is interesting to note that, regardless of the reference figure used, the shape of the geoid does not lend any particular support to the suggestion of Girdler (*7*) that the rift valleys and the mid-ocean ridges are the loci of up-currents in a convection system. It has been shown, by Licht (*8*) for example, that the top of a convection current should be in the area of positive gravity anomalies.

The positive anomaly areas near Central America, West Africa, and the East Indies are not associated with any ocean ridges. On the contrary, the ocean ridge system extending from the northwest Indian Ocean, around south of Australia, and up to the east Pacific is strongly correlated with a negative belt in the gravity field.

A similar negative correlation exists between heat flow and the gravity field, as shown by Lee and MacDonald (*9*), whose harmonic analysis of thermal measurements shows areas of maximum heat flow in central Asia and the eastern Pacific, and areas of minimum heat flow in the south Atlantic and western Pacific.

The various correlations shown are suggestive of what hypotheses to pursue, but they undoubtedly have a strong subjective element, and need both firmer mathematical models and more extensive data: in particular, more widespread gravimetry.

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Geomagnetic Polarity Epochs: Sierra Nevada II

Abstract. *Ten new determinations on volcanic extrusions in the Sierra Nevada with potassium-argon ages of 3.1 million years or less indicate that the remanent magnetizations fall into two groups, a normal group in which the remanent magnetization is directed downward and to the north, and a reversed group magnetized up and to the south. Thermomagnetic experiments and mineralogic studies fail to provide an explanation of the opposing polarities in terms of mineralogic control, but rather suggest that the remanent magnetization reflects reversals of the main dipole field of the earth. All available radiometric ages are consistent with this field-reversal hypothesis and indicate that the present normal polarity epoch (N1) as well as the previous reversed epoch (R1) are 0.9 to 1.0 million years long, whereas the previous normal epoch (N2) was at least 25 percent longer.*

A recent paleomagnetic investigation (*1*) of six radiometrically dated igneous rocks of late Pliocene and Pleistocene age from the Sierra Nevada of California led to the conclusion that if the polarity epochs of the earth's magnetic field are equal or nearly equal in length, then they are either ½ or 1 million years long. Normal polarity epochs are defined in terms of the geomagnetic field-reversal hypothesis