Bread.
Oleomargarin.
Tea for adults.
Milk for youngest child.
Dried apple pie with cheese for adults.
Dried apple sauce for others.

THE APPROXIMATE COST PER DAY AND THE NUTRITIVE VALUES IN CALORIES APPEAR BELOW

	Amount	Calories	Cost in Cents
Coffee	2⅓ ounces		3
Tea	½ ounce		2
Milk	3 quarts	1,800	27
Bread	2 pounds	2,500	9
Cereal	½ pound	800	4
Oleomargarin	⅜ "	2,500	19
Corn-syrup	⅛ "	650	2
Sugar	¼ "	450	2
Rice or macaroni	1 "	1,600	8
Dry navy beans	10 ounces	1,000	7
Fat pork	6½ "	1,000	6
Dry fruit (prunes)	1 pound	325	12
Flour, lard, etc., for pie or other extras		1,800	15
		14,425	116

As cheaper meats, pork sausages, braised chuck rib of beef, salt cod or herring may be added if finances allow.

This is one method of giving scientific advice. I believe that it may be also possible to arrange in convenient locations throughout a town grocery stores with milk stations adjoining, and that here baskets may be exchanged daily, an empty one for a full one, the baskets varying somewhat from day to day but containing 5,000, 10,000 or 15,000 calories of basic food fuels.

We are told that Joseph fed the Egyptians with grain stored during seven years of plenty. Whether the municipality of the future will purchase wheat and ration bread in quantities sufficient for its inhabitants is a serious question. The railroads of the country receive three thousand million dollars for the service which they render. They must pay high wages and must not increase their charges for what they have to sell. The food problem involves a national expenditure of at least six thousand million dollars a year. The food problem is a national problem which more directly affects living expenses of the very poor than any other problem. The railroads do not enhance the cost of food more than four per cent. of its total cost. The cost of food is, as has been shown, not always dependent upon the cost of production. The cost of gas is regulated by the state and yet the gas companies pay dividends. The cost of bread may some day be lowered by reducing the number of middlemen and by some sort of state control. It is important, also, to find some means to increase the supply of milk. This might be encouraged by a tax on steers of ten dollars each, payable every six months, a procedure which would enhance the price of beef but would induce the farmers to feed their fodder to milch cows or to pigs.

This has brought me to the point where I started—that the professor may get lost in his own back yard. However, it does seem to me that this is a proper time for an American commission to consider these subjects and to report to our government what elemental advice the commission might agree to give. Surely, some consensus of opinion might be arrived at by a commission meeting in Chicago and composed of Mendel, Taylor, McCollum, Folin, Levene, Sherman, Armsby, Langworthy and Benedict. This would mean the submergence of the individual for the instant, in an attempt at welfare work for the nation at large. It would be an experiment worth trying.

Graham Lusk

New York City

GRAVITY AND ISOSTASY

There has recently been issued from the government printing office a volume of 196 quarto pages, known as Special Publication No. 40 of the Coast and Geodetic Survey, bearing the title, "Investigations of Gravity and Isostasy," written by Mr. William Bowie.

This volume is so important to geodesists and geologists that the undersigned believes that its appearance warrants more attention than merely a review of the ordinary kind and length. Hence the present article is presented. The volume is of especial interest because it is based on many more observations of gravity than were formerly available in the Coast and Geodetic Survey, and because the discussion of the data is much more searching and complete than anything heretofore published.

The last preceding publication on this subject from the Coast and Geodetic Survey was issued in 1912.[1] The conclusions in that publication were based almost entirely upon the 124 gravity stations in the United States and 10 in Alaska. In the present publication conclusions are based primarily upon observations at 219 stations in the United States and are tested by observations at 42 stations in Canada, 73 in India and 40 in other parts of the world—374 stations in all. This increase in the number of stations and of the area covered by them is important because the reliability of the conclusions drawn depends upon the completeness with which effects peculiar to a given station or a locality are eliminated, and upon the extent to which supposed general laws are found to be confirmed by the evidence from widely separated areas.

Within the past four years there has been one radical change in the relative method of observing gravity in the United States, with the half-second pendulums, the standard method of the Coast and Geodetic Survey. Formerly each gravity observer carried a transit instrument with him and determined the errors of his chronometers on each clear night. Now he determines the chronometer errors by the time signals sent out from the Naval Observatory at Washington, special studies having shown that these signals are of ample accuracy for the purpose. The time and expense necessary for securing a gravity determination at a station is thus materially reduced, and the rapid increase in the number of gravity stations which is the prime essential of future progress is facilitated.

The most severe test which may be applied to a theory, or a supposed understanding of a group of facts, is a test by prediction. Such a test has been applied by the writer recently to the Coast and Geodetic Survey theories as to the intensity of gravity, including the method there used for computing the effects of topography and isostatic compensation. In the 1912 gravity publication already referred to (Special Publication No. 12) there is a map of the "lines of equal anomaly for the new method of reduction." This map, based upon 124 gravity stations in the United States, may be used in combination with computations for which the methods have been fully published, to predict the intensity of gravity at any point in the United States. Such predictions, for 95 gravity stations, based on the 1912 map have been made by the writer,[2] and compared with the observations made after 1912 at those stations. The difference of prediction and observation was less than .02 dyne (1/49,000 part) in 54 out of the 95 cases. Such a prediction may be made in about three days by an expert computer in Washington at a cost to the government of about $25. On the other hand if a physicist undertakes to determine gravity in his own laboratory by an absolute method, past experience shows that after many weeks of time and an expenditure, including salaries, of many hundreds of dollars, it would be an even chance whether his final result would be within .03 dyne of the truth. To reduce the probable error sufficiently to be equal to that of the prediction which may be made in Washington in three days by a computer would require the equivalent of months of time by an expert physicist.

Still more accurate predictions are certainly now possible by the use of the 1917 map, based on 261 stations in the United States and Canada, which is necessarily a decided improvement for prediction purposes over the

[1] "Effect of Topography and Isostatic Compensation upon the Intensity of Gravity," by William Bowie, Special Publication No. 12.

[2] The writer took advantage in making these predictions of detailed computations which had been made at Washington of the effects of topography and isostatic compensation at these stations.

1912 map, which was based on 124 stations only.

Mr. Bowie's general conclusion in regard to isostasy in the United States is as follows:

> The group of publications of the Coast and Geodetic Survey dealing with deflections and gravity values shows that isostasy exists in a form nearly perfect in the United States as a whole, also that there is nearly perfect isostasy in areas which form comparatively small percentages of the area of the entire country.

The abundant evidence presented supports this conclusion fully. It is important to note that a conclusion of this general character was originally based, not much more than ten years ago, on a small fraction of the evidence now available and that although the amount of evidence has increased greatly, and the evidence has been studied much more intensely, the general conclusion has simply been confirmed abundantly and repeatedly—being modified only in details.

The largest anomaly noted in the United states to date, at Seattle, Washington, —.093 dyne, was recognized as a very large anomaly as early as 1910, when only 89 gravity stations were available in the United States. Since that time with an increase in the number of stations to 219 it is interesting to note that no other anomaly larger than .059 dyne has been found in the United States. So also when the study was extended to Canada (42 stations) the largest anomaly there discovered was only —.045, and in India (73 stations), the largest discovered was —.078 dyne. In other parts of the world only four anomalies have been found which are larger than that at Seattle. Each of these four is on an oceanic island or near a steep continental shore. The anomalies referred to in this paragraph are the residuals after topography and isostatic compensation have been taken into account in the computation. The extension of the computation of isostasy, in a form based upon a few stations in a restricted area, to other stations and to other areas, shows an agreement with the facts which is substantially as close at the new stations and in the extended area as at the original stations in the original area.

Two additional gravity stations having now been occupied near Seattle, it is evident that this largest anomaly in the United States, —.093 dyne, is a comparatively local matter, not a characteristic of a large area. The writer understands that additional unpublished observations emphasize this statement still further.

It is evidently desirable to supplement studies of gravity made by means of stations scattered widely, and somewhat uniformly, over a large area such as the United States, by intensive studies of selected small areas in which a large number of stations are concentrated. The beginning of one such study has been made in the vicinity of Washington, D. C., where observations have been made at seven stations within twenty miles of the capitol.

No discernible general relation is found between areas of recent erosion or recent deposition, on the one hand, and areas of negative anomaly or of positive anomaly, respectively, on the other hand.

The strength of the proof of the validity of the method of computation used in the Coast and Geodetic Survey for taking into account the effects of topography and isostatic compensation upon the intensity of gravity depends in part upon the extent to which the remaining anomalies seem to be independent of the topography around the stations. Hence special intensive studies upon this point have been made repeatedly at the survey. The latest evidence, as set forth in this publication, shows the remaining anomalies to be almost, if not quite, independent of the topography. There is a slight apparent tendency for coast stations to have negative anomalies. But the indications are that this tendency is due to the prevalence of Cenozoic formations along the Atlantic and Gulf Coasts of the United States, not to the nearness of the stations to the coast.

No other method of computation which has been published gives anomalies which are thus independent of the topography.

There is found to be a decided tendency for gravity stations located on Cenozoic formations in the United States and in India to

have negative anomalies, that is, for the intensity of gravity to be below normal at these stations. On the other hand, for stations in the United States on pre-Cambrian formations there is a decided tendency toward positive anomalies, that is, for gravity to be in excess. The evidence of a tendency toward defective gravity in regions in which the surface geologic formations are comparatively recent, and toward excessive gravity where old geologic formations occur at the surface, is full of inconsistencies, and is weak except for the two extremes, the Cenozoic and the pre-Cambrian. It is very suggestive that as the number of stations considered was increased the evidence has become more clear and convincing. The writer believes that the apparent relation cited is real and that it is important to determine, if possible, the true reason why the relation exists. At this, as at many other points, Mr. Bowie is properly cautious in interpretation, though vigorous in presenting the facts and in calling attention to the evidence of relations between the facts.

Mr. Bowie examined fourteen pairs of gravity stations in which the two stations of each pair are at very different elevations, although they are separated by a comparatively short distance in a horizontal sense. In one typical pair, one station, Yavapai, Arizona, is on the edge of the Grand Canyon of the Colorado, and the other station of the pair, although only 2,600 meters away in the horizontal sense, is 1,330 meters lower, in the bottom of the canyon. It is found that in thirteen of the fourteen cases the anomalies remaining on the Coast and Geodetic Survey basis of computation are such that if the anomaly at the lower station is subtracted from the anomaly at the higher station the remainder is positive. The average of the fourteen differences is +.014 dyne. This seemed to indicate that there is some error in the formula used to compute the correction to gravity for elevation. But "a careful study of the matter showed no error in the formula, but it seemed to indicate that the difference in the anomalies could result from the combination of several causes no one of which could alone make the difference."

Mr. Bowie has made an extensive, ingenious and careful study to determine from gravity observations the most probable depth of compensation. The methods of study and the results are fully set forth in the publication. Much difficulty was encountered arising from the intimate manner in which this unknown quantity is unavoidably entangled with other unknowns in the computations, and from the non-sensitiveness of the computed results to an assumed change of depth. There is also some evidence of systematic errors affecting the computed depth. Nevertheless Mr. Bowie has succeeded in getting from the gravity observations an independent determination of the depth of compensation. His conclusion is that the most probable value of the depth of compensation is 96 kilometers and that future values "derived from much more extensive data will fall between 80 and 130 kilometers." Having a keen realization of the difficulties of determining the depth of compensation, the writer recognizes this as a welcome confirmation of the independent and stronger determination of the depth by means of observed deflections of the vertical. The conclusion from the deflections of the vertical in 1910 was that the most probable value of the depth of compensation is 122 kilometers and that it is practically certain that it lies between 100 and 140 kilometers.[3]

Both these computations of the limiting depth of compensation are based upon the assumption that the compensation is uniformly distributed with respect to depth. In each case also the value is believed to be the average depth, it being conceded that the depth may possibly be different in different regions.

Mr. Bowie has computed the reciprocal of the flattening of the earth from gravity observations at 348 stations, of which 216 are in the United States and the remainder in Canada, India and Europe, and finds it to be

[3] "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," by John F. Hayford, published by the Coast and Geodetic Survey, p. 77.

297.4 ± 1.0. The value of this quantity derived in 1910 from observed deflections of the vertical in the United States was 297.0 ± 0.5.[4] The very close agreement between these two independent values, an agreement which is well within the probable error of either one, is strong evidence both of a very high degree of accuracy of each and of very successful elimination of systematic errors.

Helmert's value of 1915 is 296.7 ± 0.4. It is based upon 410 gravity stations in various parts of the world. These stations were selected carefully with reference to their relation to topography, a precaution which is necessary with Helmert's method of computation, though not with Mr. Bowie's method. Helmert's method of computation differs radically from that used by Mr. Bowie, yet the two end results are in close agreement.

It is the writer's opinion that Mr. Bowie's monograph on the topic "Investigations of Gravity and Isostasy," is a notable contribution to geodesy. It furnishes a new and broader basis for further studies by geologists and students of geophysics. It furnishes new evidence of the steadily increasing skill and energy with which the Coast and Geodetic Survey is attacking the scientific problems which come within its scope. It is hoped that this article touching upon a few of the main points in the monograph will help arouse such interest as will lead to study of the monograph itself.

John F. Hayford

College of Engineering,
Northwestern University,
Evanston, Ill.

THE NATIONAL ACADEMY OF SCIENCES

The following abstracts have been received of the papers to be presented at the stated meeting of the National Academy of Sciences to be held in Washington on April 16, 17 and 18.

Sex-Determination and Sex-Differentiation in Mammals: Frank R. Lillie, The University of Chicago.

Sex-*determination* in mammals is zygotic, but it does not imply an irreversible tendency to the indicated sex-*differentiation*. Intensification of the male factors of the female zygote from the time of onset of sexual differentiation by action of male sex hormones may bring about very extensive reversal of the indicated sex-differentiation. This result is attained by a study of the twins of cattle. The way is open for an experimental examination of the limits of such reversal, and for an examination of the possibilities in the case of the male zygote.

Sporogony of Malaria Parasites: Photomicrographs of Infected Anopheles: W. V. King, Ph.D., Bureau of Entomology. (Introduced by L. O. Howard.)

The cycle of development through which malaria parasites pass in the body of anopheline mosquitoes has been described in more or less detail by several authors. The illustrations of the developmental phases are, however, mostly taken from drawings which are often schematic and in some cases misleading. The opportunity is therefore taken for presenting the accompanying series of photomicrographs representative of the various stages in the complete sporogonic cycle, and a brief explanatory description of the development as observed in fresh preparations of infected mosquitoes. A few differences from the description as given in some of the texts have been observed and these are substantiated by the illustrations. The work was done in the laboratory of Dr. C. C. Bass, Tulane University, New Orleans.

The Great Barrier Reef of Queensland, Australia: W. M. Davis.

In recent years a number of students of coral reefs have concluded that the Great Barrier Reef of Queensland has been built up on a slightly submerged platform, of origin independent of coral growth and presumably similar to that of the continental shelf which borders the eastern coast of Australia, south of the limits of coral reefs.

There is, however, good reason to think that the present immature reef is an upgrowth from a submerged mature reef plain of an earlier time, if the changes of level that have taken place in the highlands inland from the coast are considered. Following the studies of E. C. Andrews, of Sydney, the highlands of eastern Australia in the region near the boundary between New South Wales and Queensland show the work of several cycles of erosion, each separated by an uplift of several hundred or a thousand feet. When these uplifts took place, the off-shore belt must have been de-

[4] "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy," p. 77.