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National Ocean Survey

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## Geographic Center of the United States

The admission of Alaska and Hawaii to the Union as States during 1959 has aroused public curiosity as to where the geographic center of the United States lies.



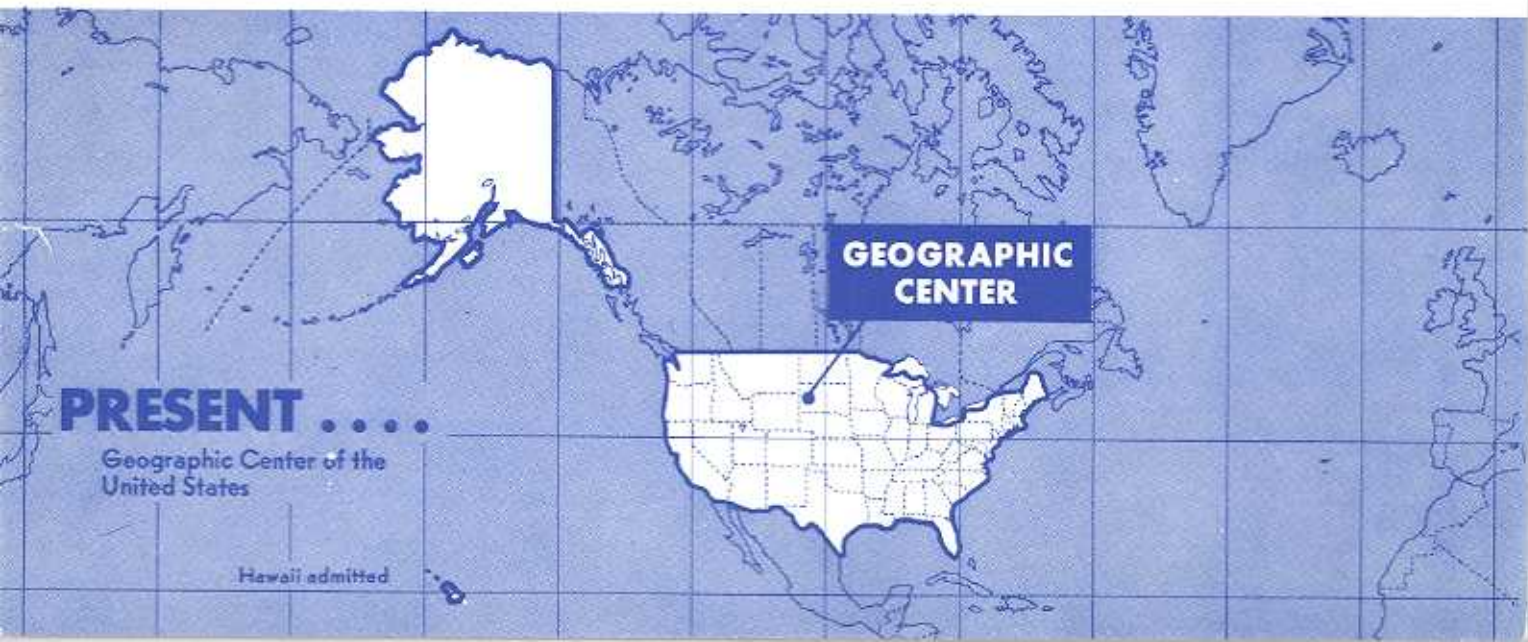
Determining the geographic center of an irregular area on the earth's surface is a precarious business at best. There is no unique solution and none of any scientific significance. Several methods of approach are available. The one employed by the National Ocean Survey is probably best termed as the center-of-gravity method. Imagine a map of the area for which the geographic center is to be determined, has been placed on a piece of cardboard of uniform thickness and that this is cut carefully along the outline of the map. The center of gravity of this map outline or what might be called the geographic center, is that point at which the map will balance.

The geographic center of the forty-eight conterminous states was determined by the National Ocean Survey, formerly the Coast and Geodetic Survey in 1918 by the method described. This geographic center is approximately at latitude  $39^{\circ}50'N$ , longitude  $98^{\circ}35'W$ , near Lebanon, Kansas. When Alaska was admitted to the Union, the geographic center of the forty-nine states shifted about 439 miles northwest to a point at approximately latitude  $44^{\circ}59'N$ , longitude  $103^{\circ}38'W$ , about eleven miles west of Castle Rock, Butte County, South Dakota. In arriving at this determination the geographic center of Alaska was determined by the method

described and was found to be at latitude  $63^{\circ}50'N$ , longitude  $152^{\circ}00'W$ , with an uncertainty of about 15 or 20 miles in any direction. The geographic center of the combination of Alaska and the forty-eight conterminous states is considered to be on the great circle connecting their geographic centers at a point where the two areas would "balance"; i.e., considering each having a weight, proportional to its area, concentrated at the corresponding geographic center.

Later when Hawaii was admitted to the Union, its geographic center was determined to be at latitude  $20^{\circ}15'N$ , longitude  $156^{\circ}20'W$ , with an uncertainty set at about 3 or 4 miles in any direction. The geographic center of the fifty states was then determined as being on the great circle connecting the geographic centers of the forty-nine states and Hawaii at a point where these areas would "balance." The effect of including Hawaii was rather small since its area is only about 1/560 of that of the forty-nine states. The geographic center of the fifty states, thus determined, then shifted about six miles west-southwest to latitude  $44^{\circ}58'N$ , longitude  $103^{\circ}46'W$ , which is approximately 17 miles west of Castle Rock, Butte County, South Dakota. The uncertainty of this determination is set at about 10 miles in any direction.

MI-4





# Geographical Centers

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IT is a characteristic of human beings that they are curious about things of which they have no definite knowledge. On the whole, this is a laudable trait but often curiosity outruns intelligence. It is true that there are more things in heaven and earth than are dreamed of in our philosophy, but we should allow our intelligence to curb our curiosity in cases where it is needed and should not insist upon a definite statement where no exactitude exists.

A great many people are curious about what they call the geographical center of a state or a country or even of a whole continent. Now, let us examine into this matter and find out, if possible, what may be the meaning attached to this idea of geographical center of any given area.

If we take a bounded plane surface we may, under certain circumstances, get some reasonable meaning into the idea of geographical center or, as it would be in this case, the center of area. If the region under consideration is a connected surface bounded by a regular system of lines such as a regular polygon or a circle, then, what is called the "center" will be the center of area. It will also be the center of gravity when the surface is considered as a thin plate. The essential requirement is that the area must be exactly symmetrical with respect to this so-called "center of area." If the boundary is irregular so that no symmetry is present, then, any attempt to find a center of area will meet with difficulty. There will still be a definite center of gravity but this point will hardly be a satisfactory center of area. The suggestion has been made to draw a straight line across the area, such that half of the area lies on one side of it and the other half on the other side. Then draw a second straight line perpendicular to this first line, also dividing the area into two equal parts. Then the intersection of these lines would be the center of area. This is very good as far as it goes, but in what direction should these lines be drawn? If the figure, as stated before, is a symmetrical one, it would not make any difference in what direction the lines were drawn, for any line drawn through the center would divide the area into two equal parts. But if symmetry is not present, the position of the intersection of the two lines would depend upon their direction. That is, the intersection of the north-south, east-west lines would not be the same as that of the northeast-southwest line with the northwest-southeast line. Also, the center of gravity of the area would not be satisfactory, for any protuberance in any direction would tend to pull the point in that direction.

Now, we have been discussing merely a plane area; but any region on the earth is a portion of a spherical surface or, if we wish to be very exact, it is a portion of the surface of an ellipsoid of revolution. But it may be objected that a plane map may be made of the country or state and then the center of area of this plane surface can be determined. This is all well and good but no map of a spherical surface can be made that is not distorted in some way. We can make a map that has constant area ratio, but, if so,

distortions in shape must take place, so the representation is not a true representation of the actual surface. We have already seen that, even if it were a true representation, the center of area would have no meaning unless the outline were symmetrical such as a circle, an ellipse, a square, or other figure of similar class. Unfortunately, countries and states as political units or as physical features of the earth are not so constituted.

It may be suggested that we could make such a determination on the surface of a globe and so attain some definiteness. But here we run into new difficulties. If we wish to define the center of area as the center of gravity of the surface, such center would not even lie in the surface but would be some distance beneath the surface of the globe. On the other hand, if we wish to make the determination by the intersection of two lines mutually perpendicular, such that each of them divides the area into two equal parts, what lines should be adopted for the purpose? If we take one of them to be the meridian, should the other be an east and west great circle or should it be a parallel? Two mutually perpendicular great circles in any other directions would necessarily give a different point due to the lack of symmetry in the region considered. When the matter is looked at in any way, elements of uncertainty arise and we must conclude that there is no definite center of area or geographical center of any political or physical divisions of the earth's surface.

In the United States Coast and Geodetic Survey we receive many requests for information regarding the geographical center of the United States or even sometimes regarding that of the whole of North America. Different results have been given by different investigators and at times we are requested to arbitrate the rival claims. From the preceding discussion it is seen that this discrepancy of results is to be expected. As a matter of fact, the conclusion is forced upon us that there is no such thing as the geographical center of any state, country or continent. The point determined will depend entirely upon the definition given by the one making the computation. No account should be taken of a characteristic of an area that will depend entirely upon the supposition made in its determination. If there were some rational definition so that all computations would necessarily lead to the same result, then some meaning might be attached to such a result. However, in most cases it is nothing but idle curiosity that leads to an interest in such a point, or some man may want it definitely located in his front yard. To all such the warning should be given that the point is much like the proverbial flea; when you think you have it you have it not.

A method that was used in the Coast and Geodetic Survey a number of years ago was the following: An equal-area map of the United States was constructed on thin cardboard and then the outline map was cut out along the various boundaries. The center of gravity of this outline map was then deter-



mined. This could easily be done if it is assumed that the cardboard is perfectly homogeneous and everywhere of the same thickness. These are ideal conditions that are probably never found actually to exist. However, assuming this to be true, we need only to suspend the figure from some point and draw a vertical line on the map from the point of suspension. Then the same is done from another point, preferably so that the second vertical line is approximately at right angles to the first. The intersection of these two lines will be the center of gravity of the area in question under the assumption stated above. This point can then be considered the geographical center if it is satisfactory so to define it.

Let us give a little further consideration to this procedure. As already stated, an equal-area map has the same area ratio at all points but, in order that this may be true, it is necessary to distort the shapes and this distortion becomes greater as the area mapped increases. This fact would have an influence upon the shape of the outline of the country as it is cut from the cardboard. Equal-area maps of the same country constructed on two different projections would give different results for the center of gravity of the outline. In each case a perfectly definite center of gravity for each outline would be determined, but when scaled in terms of latitude and longitude from the different maps the results would not agree. If a similar attempt were made with the outline cut from the spherical surface, a result not in agreement with any of the plane maps would be found. Also projecting regions such as Florida and Maine in the United States would have an undue influence upon the location of the point to be determined. In view of all these considerations it is clearly seen that the definition of the geographical center as a center of gravity is far from satisfactory.

We shall now examine the method of two perpendicular lines, each of them dividing the area in halves. We might attempt this on an equal-area map with straight lines, one north-south and the other east-west. In the first place the practical difficulty in the way of such a method is very great. We could quite easily determine an approximate area for the whole map with the use of a planimeter but no great exactness could be obtained. However, the attempt to determine a north-south line that accurately bisected the area would meet with serious difficulties. After a number of trials one might finally arrive at an approximate result. Also by cutting the map in two and weighing the parts against each other after

several trials an approximation might be found. Let us suppose the two required lines have been found. Then their intersection may be assumed as the geographic center of the map. Here we meet with the same objection as before. The location of the point in terms of latitude and longitude would depend upon the kind of projection used in constructing the map; also any two lines similarly drawn in different directions would give a yet different result. Again, if we resort to the globe the same objections apply with still greater practical difficulties to contend with.

In regard to the United States, almost any of these methods would probably locate the point somewhere in the State of Kansas, but at just what point in terms of latitude and longitude one would be rash to state. It would seem then, in view of these uncertainties, that it is not an advisable thing to do to make any definite statement regarding the matter. Since there is no definite way to locate such a point, it would be best to ignore it entirely since any statement regarding the position of the point may be called in question by one who considers the matter from another point of view. If it were only possible by any analytical process to determine a definite point that could be reproduced by any other person with the same assumption, it might be well to take some stand in the matter. But as things are constituted, the resulting point would not only depend upon the definition adopted but would also depend upon the investigator and upon the tools employed in the investigation. The conclusion seems to be that it is hazardous to make any definite statement about a matter that can be viewed in so many different ways that inevitably lead to discordant results.

If the fact is recognized that no method of determination of a geographical center of a country is entirely satisfactory, and if it is admitted that such a point can not be uniquely determined, then it is true that almost any one of the methods already outlined will give a point that is accurate enough for all practical purposes. As a matter of fact, it is hardly conceivable that such a point should meet any "practical purpose" in any case. It is a conception that depends almost entirely for its existence upon the curiosity of mankind. It is inevitable that there are as many geographical centers of a state or country or other area as there are persons determining them. Any reasonable method employed will give a center as satisfactory as any other one. This is a case in which all may differ but all be right.