

## The Keynote Address

### *Maps as the Heritage of Mankind\**

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IT IS unusual for an astronomer to give a keynote address to people who are earth-bound in their avocation of mapping the earth. Of course, you could not have done very much without stars, without the rotation of the earth or without the timekeepers who give us the longitudes we need for any distance to be measured on the surface of the earth.

Having been in charge of a time service similar to that at the Naval Observatory in the Philippines for three years, I presume I am qualified for at least one dimension, and that is longitude.

I am going to talk to you, however, about something entirely different from the measurement of longitude. Everybody has a hobby on the side, and one that has intrigued me for several years has been old maps and new maps.

I like to look at them; I like to see how much work has gone into the delineation of a contour or of an elevation on a map. I have wondered who does all this work? Who wanders afield? Who has measured the elevations; who measured the coast lines, the latitudes and the longitudes?

Because every time there is a detail that is put down accurately on an ancient map, there must have been somebody there who set foot on the spot. Who has not looked at a very old map and wondered how much real labor and study went into it, not only on the part of the man who brought in the original data but the man who finally compiled it from all sorts of data and made it what it is.

Some very old maps appear very crude. They are no better than some of the directions you receive from a friend who invites you to his country home and draws it on the back of

an old envelope. As long as he indicates the right number of turns in the road and shows you the number of streams you are to cross, you can probably find the place without too much difficulty.

In the same way, some of the most primitive maps have shown the the right number of turns in a river; they have shown the portages at waterfalls and even have used campsites between one day's travel, which was the custom among the Indians of this country, rather than longitudes. Each campsite, whether you were climbing a mountain for a day or walking rapidly across a plain, would be spaced equidistant apart.

Thus, the sources of scale in many very old maps which have been found are quite arbitrary. But we have some maps which do not have such an arbitrary scale, but actually had a mental picture of the entire area which he could reproduce from memory.

An example of this is shown in the book by Raisz entitled "General Cartography." A part of northern Canada covering an area of several hundred square miles was drawn by an illiterate Eskimo. When you compare it with a very carefully prepared map, you are amazed at the accuracy with which this individual remembered minute details and scale. It is upon this type of person that I believe many of the very ancient maps we have depended for their amazing accuracy.

Most intriguing of all, of course, is the work of the compiler whom we find here and there in the history of mapping. I shall talk about a couple of these people.

Compilers are the men who have gathered the information that has come helter skelter from different travelers and voyagers. The compilers are able by the best means at their

\* ASP-ACSM General Assembly, Main Ballroom, Wednesday, March 27, 1963 at 1:00 P.M.

EDITOR'S NOTE: Father Heyden has been Director of the observatory at Georgetown University since 1948. This well-known scientist was Chief Astronomer of the Manila Observatory from 1931-1934, and a member of the eclipse expeditions to Brazil in 1947 and to China in 1948. He has designed equipment, trained personnel and selected the observation sites for a number of U. S. Air Force-sponsored eclipse expeditions to many parts of the world, including, most recently, Sudan and Iran. Father Heyden has written numerous articles on scientific subjects for a number of technical journals and is an authority on the photo-electric method of observing solar eclipses. He is a consultant for the National Aeronautics and Space Administration on applications of space relationships. Father Heyden was recently named by the Washington Academy of Sciences as "Science Teacher of the Year."

command to coordinate all of this heterogeneous information into a unified whole. That, of course, has been the principal task of all of you with the advantages of modern techniques.

Perhaps the earliest known map of this sort was that done by the Alexandrian scientist and astronomer, Eratosthenes, who is credited with having compiled a map of the then known world on which he shows the British Isles, a good part of Siberia, India, Ceylon, the whole Mediterranean area, the Iberian Peninsula and North Africa.

The unusual feature of this map by Eratosthenes is the coordinate system similar to the mercator projection which was introduced centuries later.

Eratosthenes, of course, did know something about coordinate systems. He was an outstanding astronomer. He also had an advantage in gathering the data for his map in the library at Alexandria, of which he had charge. It was a relatively new library at that time because it had been founded by Alexander the Great. With all of this material at his command, he produced his map of the world, which was lost along with the original data in the destruction of the library at the time of the rise of the Moslem empire. This same empire which did so much devastation in the beginning, was to produce a number of eminent scientists and astronomers a few centuries later.

Only a description of Eratosthenes' map of the world survived. The map itself was destroyed, but it has been reproduced only from the description.

Eratosthenes probably holds the title of having made the first map of the world.

Ptolemy, who came three centuries after Eratosthenes, was the next great compiler of ancient maps; and from then on, the art of mapping became routine with explorers saving their little drawings prepared mostly for coastwise navigation. Not much effort was directed toward a map of the entire known world, until fairly recent times. It does appear that there were maps which could be trusted with some degree of accuracy.

I have studied a few such maps with a friend of mine whom I have known for many years. He is about 80 years old now and has been having a wonderful time collecting ancient maps. His name is Arlington H. Mallery. Whenever he drops in for a visit, we talk about the many things he hopes he can find some day from such maps.

I do not know how much interpretation can be gotten directly from them. All I ask while

looking at them is, where did all the evidence for drawing these maps come from?

One map, a very ancient one, shows a part of Alaska. Whoever added the annotations in the course of time has made me wonder about the exploration entailed in it.

Mr. Mallery tells me that he heard about it through a Norwegian sea captain. On it you will find that there are two words which refer to a "muddy glacier" and "lava beds." There are scarcely any traces of these features now, but evidence of them has been found in the preparation of the Geological Survey. One estimate of the age of the "muddy glacier" is about 1,500 years.

Another ancient map of the North Atlantic showing Greenland and Labrador was used by Father Erlend Thordsen and published later by Zeno. Certainly, this particular map existed before some of the most modern surveys and explorations of the country. It indicates that there have been voyagers there with competent surveyors among them. Whether or not we shall ever be able to fully explore all of the information that these people brought back with them and have preserved is a question that we should try to answer in the future.

I have often wondered about the way certain islands and other land masses have been put together on these ancient maps. I believe that the compilers did not pay much attention to the transoceanic distances in those days. When at sea, they simply sailed and sailed until they saw evidence of land. Most of the ancient maps seem to have been prepared for piloting rather than for navigation.

There is another ancient map (Figure I) which indicates a projection viewed from the north and it shows the northern coast of Alaska with the Aleutian Islands going off to the right.

Another (Figure II), presumably prepared by Zeno, shows Greenland. Most of the detail is now under ice. The accuracy of these buried features has intrigued Mr. Mallery and myself. Paul Emile Victor has found evidence of these land areas which make Greenland appear to be divided into two larger land masses with a seaway between them.

The names of places have been put on this map, not necessarily by the same people who drew the map. None of these maps were prepared by one surveyor, probably not even by one group of surveyors at one time. They must represent a compilation of information that has been brought back over many generations of explorers.

How much of this is based on tradition and



FIG. 1 North Coast of Alaska with identifications by A. H. Mallery.

memory; how much on actual record and scientific measurement cannot be fully appreciated. However, much of the coastlines has been drawn by people who made actual measurements with whatever instrument they had at the time. This seems definite from most of these ancient maps.

According to some seismic explorations, there are separate land masses under the ice-

cap of Greenland. Even though other explanations are equally plausible, such as the sinking of land masses under the weight of the ice, I would still be inclined to wonder why the very old maps and modern seismic soundings agree so closely. There is a modern Geological Survey map of Alaska which indicates the traces of the lava beds and the glacier that were marked on the old map. The new map is

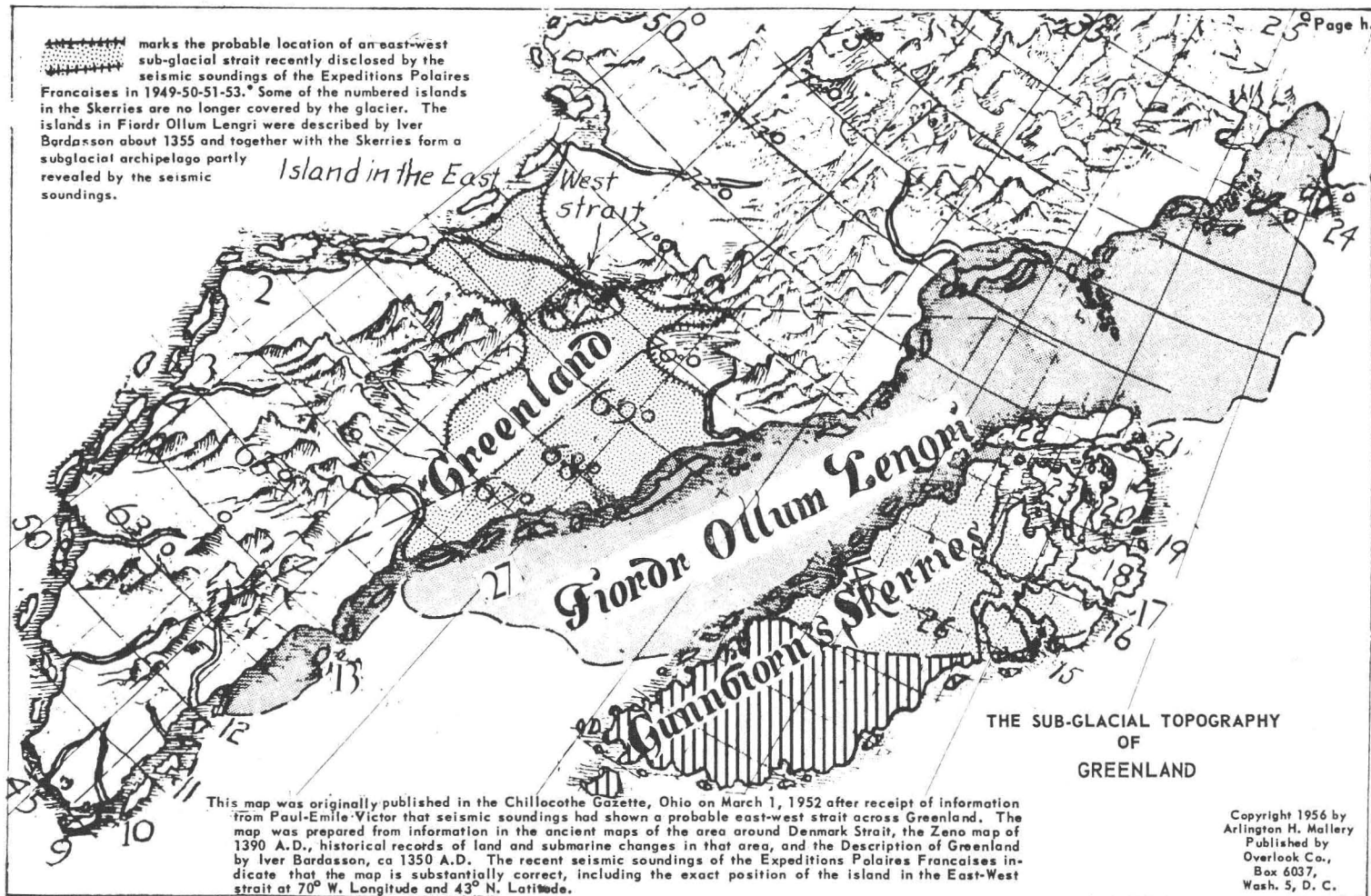


FIG. II Greenland showing sub-glacial strait found by Paul Victor.



a marvelous piece of work resulting from the efforts to use radioactive dating for the various rocks and other specimens that are found in that area.

This map contains valuable information that we hope will never meet the fate of the map of Eratosthenes.

Another very interesting map (Figure III) that has caused a lot of discussion was published by the Turkish navigator, Piri Reis, in the year 1513. He originally compiled a map of the whole known world, but only portions of his work are known today. The map of the east coast of South America showing a mouth for the Amazon River. When the two river mouths are superimposed, the entire east coastline matches the best available chart from the U. S. Hydrographic Office with surprising accuracy. This map extends all the way into North America and around through Alaska. The islands of the West Indies are mixed up with Iceland and Greenland not far away. The islands apparently are not placed according to latitude and longitude. But for anybody sailing in on a particular compass heading and seeing "land fall" of an island, the particular area of the map would serve for their piloting and navigation.

This map by Piri Reis is the first one that Mr. Mallery showed to me. He made all of the comparisons between old and new with the assistance of a friend in the Hydrographic Office. After matching the various parts of the coasts with the best known data of Hydrographic Office charts, they obtained the result shown in Figure III.

It is evident that whoever surveyed the coastline for this map had been there. This was not done by a casual voyager making rough sketches with pencil and paper as he travelled.

Piri Reis' story was that he used information from the libraries of Alexandria and some from a Spanish navigator who had been captured by Turkish pirates and who had been on a voyage with Christopher Columbus.

How valid is this map?

I have read one or two comments in books that imply it is a forgery, but this much is true: There would not be much purpose in making a forgery about two hundred years ago. There is enough evidence that the copies of the Piri Reis map in existence are at least that old. Furthermore, there is some information in the part along the northern coast of Antarctica which seems to have been known before the present ice shelf got as big and as thick as it is.

Mr. Mallery and I featured the Antarctic

section of this map with Mr. Walter of the Hydrographic Office and Father Daniel Linehan of Weston College Seismic Station in Massachusetts on the Georgetown University Forum in 1956 under the title "New and Old Discoveries in Antarctica."

In the transcript of that broadcast I put a picture of this map. We used to send out a transcript to anybody who wanted it for ten cents. When we had to send out a couple thousand transcripts of this broadcast, I got a little bit worried because it was costing more money to produce and mail them than the ten cent fee provided. I stopped taking orders when the last printing had run out.

Now I have to send ten cents back to people all over the world, even Russia and Japan because they have read about this half-hour broadcast and are interested in the Piri Reis map. Without a doubt, it has become a very, very, famous map and there are many people interested in the unknown surveyors who provided the original data.

I have never figured out what all the ships mean on ancient maps. Some people think that there is a cipher in them, but I am not competent to know whether they do more than indicate the type of ship that was travelling at that particular time in that area or whether you would need a big ship in one area and a small ship in another.

There are some stories about the explorers who obtained the data for maps in the 16th and 17th centuries. There was a Jesuit lay brother by the name of Goetz who travelled with a caravan through Tibet and across into China. We are told that he made many astrophysics observations with crude instruments in an effort to try to get a map of that area. With him were a group of natives to whom he had loaned money from funds that had been entrusted to him to bring into China. He fell sick and died before he arrived at his destination and his records of his observations were destroyed by his fellow travellers, to get rid of records of the loans he had made to them.

Brother Goetz would have made a contribution to the geodesy of that area which would have been most valuable to the Chinese and perhaps to the map makers of today.

You may not be familiar with the work of the early Jesuits who went to China with Father Matthew Ricci. They found the Chinese very interested in making maps and found many ancient ones showing the great wall and other details remarkably well. The Jesuits became the astronomers to the emperor and tried to determine the difference in longitude between Paris and Peking.

*Türk deniz kumandanlarından Piri Reis'in (Hierî-919) (Milâdî-1513) senesinde yapmış olduğu  
Atlas Okyanus ve Amerika sahilleri haritasıdır.*

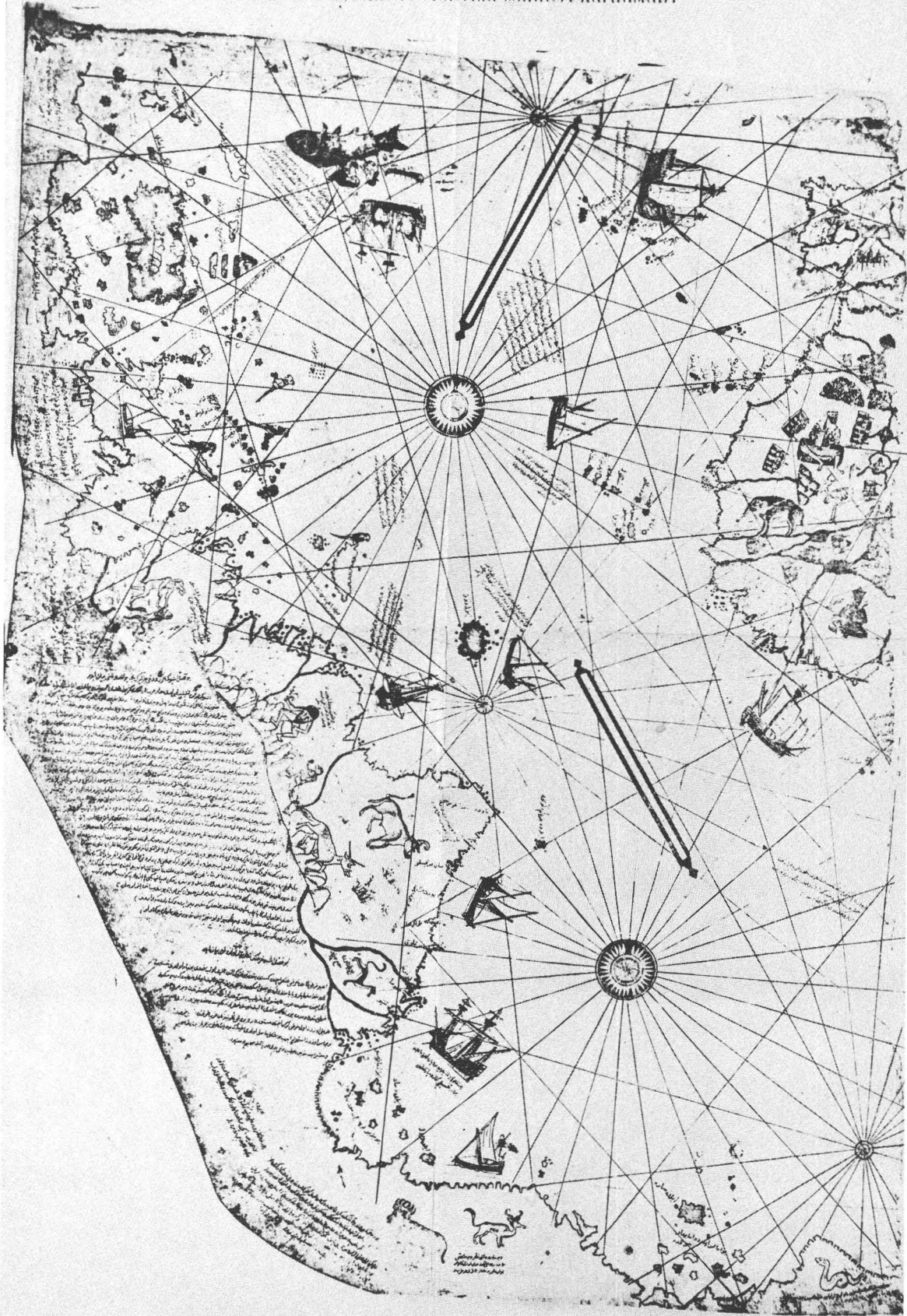


FIG. III Piri Reis map of Atlantic Ocean.

This work done by Father Verbiest and others until close to the middle of the 17th century was most valuable at the time, and you can still find it published because of the care with which the observations were made.

They used the eclipses of the satellites of Jupiter for this work. In fact, this procedure has been suggested by Galileo. It is the first long-range longitude determination that I know of in the scientific mapping of the world.

There is a map showing China and the north Pacific which is purported to have been brought back from China by Marco Polo. It was in his family for many generations. The Rossi family in California who presented it to the Library of Congress are descendants of Marco Polo. Annotations on the map have caused controversy over its validity. Without a doubt, it is a very old map and despite the scribblings by others it is probably original.

It would appear that the world was quite well explored up until the time that such maps were compiled. The navigators who brought back the information are to be congratulated.

Now this is another one of my maps. I think I will skip this one and go on to the next one that I have.

There is a map of the Philippine Islands, where I spent three years as an astronomer, published by the Coast and Geodetic Survey under Dr. Bach in 1932. It represented a complete survey by several hundred people. At one time there were five or six survey ships working in that particular area.

When it appeared, the author of the new Coast and Geodetic Survey map approached the Director of Manila Observatory. He wanted to compare it with an 18th century map that had been in use from about the beginning of that century up until the middle of the 19th century. The old Philippine map had been prepared by Father Pedro Murillo Velarde, a Spanish Jesuit. He had used a portolano type projection (Figure IV),\* and

\* It is regretted that the folded maps were such that satisfactory reproduction was not possible.—EDITOR.

had compiled it from all of the available information that had accumulated during the century and a half following the settlement of the islands by the Spaniards.

He began this work as early as 1733 in order to prepare this map, and in his report he writes that he put in all of the villages, points, inlets, ports, shoals, reefs, courses, sailing directions, rivers, forts and distances that were known. The final result was very close to scale.

In the margins around his map he gives a description of events most memorable for the history of the place. The map, therefore, shows completeness in the names of the towns and the interior topography hardly equalled in any other map of its kind. Even the sailing courses for ships that would be leaving Manila Bay for the San Bernadino Strait are indicated.

There are pictures on the other side of the map which depict the life of the people and on the medallion with the map is a history of the islands as you would have found them at the time of Lopez DeLegaspi, the conquistador who built the City of Manila. The cartographer points out that the islands are rich in gold, wax, sugar, honey, tobacco, oranges, a variety of cotton, cocoa, shells, rice, salt and corn. Every possible fruit and export have been listed here.

For these reasons Velarde's map of the Philippines has been considered one of the most exact and complete maps of its kind.

When it was superceded by a more accurate projection, it was reprinted by the Coastal Geodetic Survey to preserve it as a document for future reference.

It is sufficient that you as mappers always try to treat a map as a source of tradition, to record not only just the position of things but what they are at the time of the survey. Revisions should be put on new maps without destroying the old, so that as continents lift, as mountains are leveled, as volcanoes grow, there will always be a heritage for the people that they may know what we had on this earth, what we saw and what we measured.