a final list is compiled with the north and south stars placed in the correct order of time, the name of the star and its magnitude being taken from the star list. It is best to confine the observations to stars of greater magnitude than 4, since the image of a small star reflected off the mercury is very dim, especially when the mercury has become slightly oxidised. At the same time it is as well to jot down all the stars and select those to be used during the course of the observations, since there may be clouds in some quadrants during part of the time and in other quadrants there may not be any stars of high magnitude.

A perfect series of observations consists of 4 stars observed in a short interval; one in the north, one south, one east and one in the west quadrant, since, *on the assumption that the refraction is the same in each quadrant,* then the difference between the true and assumed altitude in the east and west stars will cancel out and give a true longitude, while the north and south stars will when combined give a true latitude. This is not strictly true, of course, unless the azimuths are also corresponding, i. e. say 40°, 140°, 220°, 320°, but the errors introduced if the azimuths do not exactly correspond will be exceedingly small.

A further point of considerable importance is that notably greater accuracy is obtained if a series of 8 or 12 stars is observed on 5 or 6 nights than if 20 or more are observed on two nights; this applies more particularly if the chronometer is giving a poor rate between time signals. In the event of the chronometer not giving a constant rate between signals, there will be an error Δt in the observed time of transit of a star which will give an error of Δt in the longitude and of $\Delta t \cos \phi \sin A$ in the latitude. If, however, the observations are taken over several nights, these errors will tend to cancel out since the times are separately determined instead of being dependent on one another.

ALUMINIUM MOUNTED TOPOGRAPHIC SHEETS.

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The distortion of the sheet has been one of the most serious handicaps in plane-table surveying. Various schemes have been attempted to eliminate distortion of paper sheets due to changes in relative humidity. Plain polished aluminium, grained surface aluminium and painted aluminium sheets have been used in very humid climates. Clear and opaque celluloid were used in wet climates but these sheets are subject to distortion about as much as paper. For a number of years the U. S. Coast and Geodetic Survey used a cloth mounted sheet. The width of this sheet is the same as the length of the plane-table board and it is attached to the board by long clips, rolling the surplus length of the sheet under the plane-table. This sheet, made of a high quality paper, mounted on cloth, has given satisfactory results when carefully seasoned prior to use in the climate in which it is to be used. The plain or grained surface aluminium sheets are not easy to work on and erasures are difficult to make.

The U. S. Geological Survey for many years has used the cloth mounted paper, except that one sheet of drawing paper is mounted on each side of the cloth, with the grain of the two sheets of paper at right angles to each other. However, when it was necessary to have the field sheets retain perfect scale, the U. S. Geological Survey began, about thirty years ago, to mount drawing paper on each side of zinc sheets, and about eight years ago began to use thin aluminium sheets, the principal advantages of the latter being weight and ease of cutting to join sections of field sheets. Recently the U. S. Geological Survey has been using thin aluminium sheets coated with white Duco paint, finding, after many experiments, that three or four applications of white Duco under-coating gave better results than flat white lacquer. These sheets are coated with an automobile spray gun and the work is usually done in automobile paint shops, where the personnel are most experienced in such work. Some excellent work has been done on these painted aluminium sheets. Similar sheets were prepared in the U. S. Coast and Geodetic Survey for several special projects but paper on aluminium, as later described, was selected in preference to the painted aluminium.

In 1925, the cartographic section of the U. S. Coast and Geodetic Survey began using two-ply bristol board mounted on 0.025" aluminium plates for the original compilations of charts. Since that date such sheets have been in continuous use and have given very satisfactory service. They are prepared in the lithographic section of the bureau, as follows :

A sheet of polished aluminium, 0.020" thickness, is cleaned with a solution of nitric and acetic acid. Reynold's two-ply bristol board is then applied to each side of the aluminium with a high quality lithographic paste. Application is made first to one side, allowing the adhesive to set for about half an hour, then the reverse side is prepared. As the moisture in the paste has a marked tendency to loosen the fibres of the paper, which makes the surface porous and adds to the difficulty of doing fine drawing, excessive moisture must be avoided in preparing the adhesive. It also should be applied sparingly. After the paper has dried, the texture of the surface is improved by applying freely with a sponge a solution of lithographic gelatine and formaldehyde in water and wiping off the excess with a soft cloth. If too much adhesive is used or if the adhesive is too wet, the slow rate of drying will cause oxidization of the metal with resulting stains in the paper. Drying should be done in a room where the relative humidity does not exceed 55 per cent for a period of not less than twenty-four hours.

These mounted plates were such a success in cartography that a similar sheet was designed for topographic work. However, the conditions under which topographic sheets are used require that they be made so that the aluminium is completely sealed between the paper and also that the paper is of heavier weight and more moisture proof than that used for cartography. Accordingly, the following general specifications were prepared for aluminium mounted topographic field sheets :

1. The paper to be of the highest quality bristol board, or equal. It must not show any change in appearance if the sheet has been sprinkled with drops of water and allowed to dry. It must be able to withstand at least fifteen repeated drawings of inked lines and careful knife erasures of inked lines across the same spot and until it is worn down almost to the aluminium and then the last layer of fibre must still take the ink with a clean sharp line.

2. The aluminium to be of the highest quality hard rolled flat sheet, free from kinks, buckling or twists and to be of a thickness from N° 22 to N° 18 BROWN and SHARPE gage, according to the size of the sheets. The sheet 18" × 24" to be N° 22 gage (0.025") and the sheet 24" × 31" to be N° 18 gage (0.040").

3. The adhesive used for mounting must be of such a quality as to assure a permanent joint between the paper and aluminium.

4. The mounting to be on both sides of the aluminum such that the paper cannot be separated from the aluminium when subjected to a humidity of 92 % for one day. The finished mounted sheets to be smooth and free from ridges, blisters and other imperfections.

5. The mounted sheets must not change their measurements in length or width between a range of 10 % and 90 % relative humidity at a constant temperature.

6. The manufacturer must guarantee that the paper will not show eruptions, corrosion spots or blisters within one year after delivery.

7. The edges of the paper to extend beyond the aluminium approximately ½" to insure permanent sealing of the edges.

Such a sheet has been manufactured in large quantities by a domestic firm for the Survey for a number of years and not only has this sheet given excellent service in the field but it seems to satisfy all the requirements as to permanency. The original sheets were made with a cheaper paper for a backing but it was found, as with the cartographic sheets, that it was necessary to use the same material on both sides of the aluminium to prevent warping of the sheet and both sides are used for topographic work when desirable.

Several devices for clamping this sheet to the plane-table have been tried and at present a metal clamping device permanently attached to the plane-table board is in use.

Mr. S. J. BAKER (*) mentions the use of aluminium mounted sheets on the island of Espiritu Santo, New Hebrides. He prepared his own paper in a manner similar to

(*) Geographical Journal, *London, March*, 1935.

that in use by the U. S. Coast and Geodetic Survey except that he grained the sheet prior to applying the adhesive. While he mentions that the object of papering both sides of the aluminium was to economize in the weight of the sheet and to provide a second sheet available in the field, if required, this feature really is secondary to the first purpose of mounting both sides of the aluminium with paper. Mr. BAKER's use of surgical adhesive tape for securing the sheet to the plane-table is an ingenious and inexpensive method. The many varieties of mounting tape now available might be used for this purpose and it would eliminate the mechanical devices now in use.

The preliminary trials of these sheets were reported on favorably by a number of field officers. Some of these reports were printed in various issues of the *Field Engineers' Bulletin*, U. S. Coast and Geodetic Survey. Lieutenant G. A. NELSON, U. S. Coast and Geodetic Survey, (*Field Engineers' Bulletin* N° 5, 1932, page 31) gave the following table demonstrating the qualities of these sheets under changing conditions of humidity:

Conditions under which used.	*Whatman's Cloth Mounted Sheet.*				*Aluminium Mounted Sheet.*	
	East-West.	*% of Change.*	*North-South.*	*% of Change.*	*East-West.*	*North-South.*
Several days in field sheet dry	14,000 m.		10,000 m.		14,000	10,000
Foggy sheet damp	14,042 m.	.30	10,050 m.	.50	No change.	No change.
Clear sheet dry	13,947 m.	—.38	9,988 m.	—.12	"	"
Clear sheet dry	13,885 m.	—.82	10,003 m.	.30	"	"
Cloudy, sheet slightly damp	14,010 m.	.07	10,025 m.	.25	"	"
Clear sheet dry	13,979 m.	—.15	10,006 m.	.06	"	"
Cloudy slightly moist	14,008 m.	.06	10,026 m.	.26	"	"

Lieutenant-Commander E. W. EICKELBERG, U. S. Coast and Geodetic Survey, made the following comment:

"To one, who has tried to read a rod while the wind was puffing up the old sheet or tried to draw a line and found a long clamp under the alidade, the new sheet is a real treat. Also I might say that in making the projection of the new sheet, viz., the construction lines, I found no difficulty in making a straight line pass through three points. It is more than one can always say about the old sheet, which is in the process of distortion or contortion every time some one opens the chart room door".

An example of the accuracy obtained on aluminium mounted sheets was cited by Lieutenant B. H. RIGG, U. S. Coast and Geodetic Survey, (*Field Engineers' Bulletin* N° 8, 1934, page 81). A number of beacons were located by topography on an aluminium mounted sheet, scale 1:10,000, and subsequently located by triangulation. The distances were scaled from the topographic sheet prior to triangulation and, of course, without knowledge of the triangulation distance.

Summing up, the advantages of aluminium mounted sheets are:

1. No distortion due to changing humidity.
2. Not so subject to wind disturbances.
3. Finer surface paper.
4. Smaller size sheet allows work to be done by several parties in the general region and from same base.
5. Not seriously affected by mist or fog.

The main disadvantages mentioned by field officers were:

1. The mounted sheets give a smaller area and, consequently, fewer available control stations on the sheet. This is inconvenient when working near the edges of the sheet.
2. The hard surface paper causes a slight increase in glare in bright, clear, weather.

"COMPARISON BETWEEN SCALED TOPOGRAPHIC POSITIONS AND COMPUTED TRIANGULATION POSITIONS".

	Scaled.	*Computed.*
Cape Fear to Smith	3570 Meters.	3570.1 Meters.
" to BHS R.R.	5675 "	5674.3 "
" to GG Tower	2338.5 "	2337.6 "
Bald Head to Smith	4207 "	4207.5 "
" to GG Tower	2340 "	2338.4 "
" to BHS F.R.	1164 "	1163.5 "
" to BHS R.R.	3007 "	3011.4 (*) "

(*) *This station fell on the flattened edge on the topo sheet and I feel that part of the error was due to this.*

In the summer of 1934, Lieutenant R. A. GILMORE, U. S. Coast and Geodetic Survey while working in the Aleutian Islands, lost one of these sheets overboard in 8 ½ fathoms of water. He recovered the sheet by securing nails to the lower end of a 30-pound sounding lead and by piercing the sheet with this improvised rig contrived to raise it to the surface. In all, four holes were made in the sheet before he recovered it. Almost all the work proposed for the sheet had been completed prior to the accident. It was in the water about forty-five minutes. After recovery it was dried carefully between cloths and newspapers (available in his camp) over a period of six hours. To-day (two years later) this sheet is in the archives of the U. S. Coast and Geodetic Survey and shows no stains nor any sign of disintegration. The distortion was measured immediately after the sheet had been dried by Lieutenant GILMORE and showed practically no distortion in length and about 0.1 mm. to 0.2 mm. contraction in 49.50 cm. of width. Practically no change has occurred in this sheet although it has been in the atmosphere of Washington, D. C. over a year, which is considerably different from that of the Aleutian Islands, where the sheet was laid out and the projection made. Such a test, inadvertent as it was, has further proved the permanence of properly constructed sheets.

The aluminium mounted sheets have given highly satisfactory results and every engineer who has used them has expressed pleasure and satisfaction with them. To be able to take a three-point fix with certainty and without the tedious process of adjusting the position for distortion is most gratifying to a plane-table topographer. When on occasion one looks through an alidade from a triangulation station and sees the vertical wire cut the center of a signal, which one has located previously by topographic methods, it (in the words of William LEYBOURN) "will give you no small satisfaction in the prosecution of your work".

A NEW MATERIAL FOR GEOGRAPHERS

(Reproduced from *The Geographical Journal*, London, March 1936, p. 286).

A new material has been put on the market under the name Correctostat. A process has been devised whereby a fine-grade paper adheres to each side of a sheet of aluminium foil, the total thickness of the metal and the two layers of paper being