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APPARATUS FOR DIRECT MEASUREMENT OF LINEAR STRUCTURES

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It is not difficult to measure the angle and direction of pitch of a linear structure with a Brunton compass, if the outcrop is readily accessible, and the lineation is not too steep and can be seen in three dimensions. It must be seen in three dimensions, of course, for an accurate measurement to be made by any method. The direction of pitch is commonly measured by standing directly above the lineation and lining it up parallel to a side, or the slot, of the Brunton compass as it is held level. This amounts to projecting the lineation onto a horizontal plane and the direction is read directly on the compass. The angle of pitch is measured by placing the lower edge of the compass on the lineation and using it as a clinometer. There is always some uncertainty in the mental projection of the lineation onto a horizontal plane, and this uncertainty increases as the angle of pitch increases. Moreover, it is necessary to make two readings with the compass in different positions, which takes a great deal of time when many readings are being made.

On small outcrops that are accessible only with difficulty, or where the lineation is steep, a more accurate method is to measure the dip and strike of a plane containing the lineation, then measure the angle in the plane between the lineation and the dip or strike of the plane. Then a graphic solution, which is very simple with a stereographic net, gives the direction and angle of pitch of the lineation.

A simple illustration will serve to show how this is accomplished. Suppose that the dip and strike of an *s*-plane have been determined as N 56°W 70°NE. A lineation in the *s*-plane makes an angle of 69° with the strike of the *s*-plane, down to the northwest. Let the projection net represent the lower half of the projection sphere, and let the projection plane be horizontal, with customary map orientation. The construction is done on a piece of tracing paper placed over the net. Make an orientation arrow at the south pole of the projection and turn the tracing paper until the arrow points to 56°W. Now a great circle 70° from the eastern margin of the projection represents the *s*-plane, and a point on this great circle 69° from the north pole of the projection represents the lineation. This part of the construction is shown in Fig. 1.

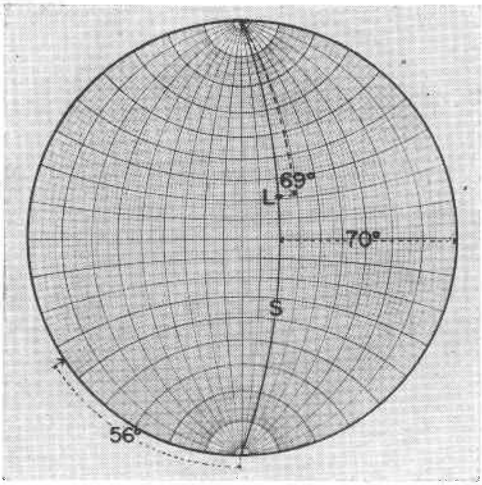

FIG. 1. Method of plotting on a stereographic projection an *s*-plane containing a lineation. Data: *s*-plane N 56°W 70°NE, lineation makes an angle of 69° with strike of *s*-plane, as measured in the plane, down to the northwest.

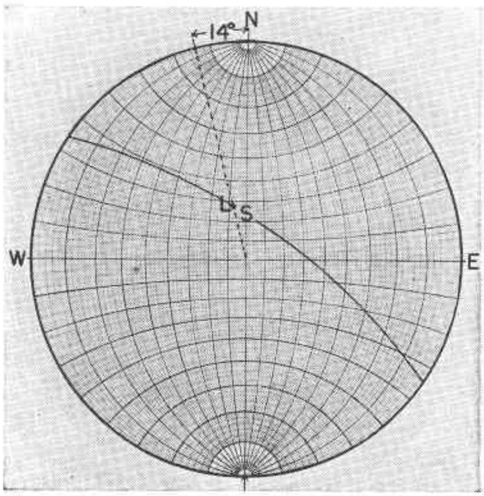

FIG. 2. Method of determining the direction of pitch of the lineation represented in Fig. 1.

To find the direction of pitch of the lineation the tracing paper is turned back to the zero point and a line is drawn from the center of the net through the point representing the lineation, to the periphery of the projection. This point indicates the direction of pitch, N 14°W in the example. Figure 2 shows this construction. The angle of pitch is determined by placing the point representing the lineation on the equator of the projection (Fig. 3) and reading the angle between that point and the periphery of the projection, between 61° and 62° in the example. Summary of data in the example: *s*-plane, N 56°W 70°NE; lineation $\wedge$ strike of *s*-plane, 69°N; lineation N 14°W 61°+.

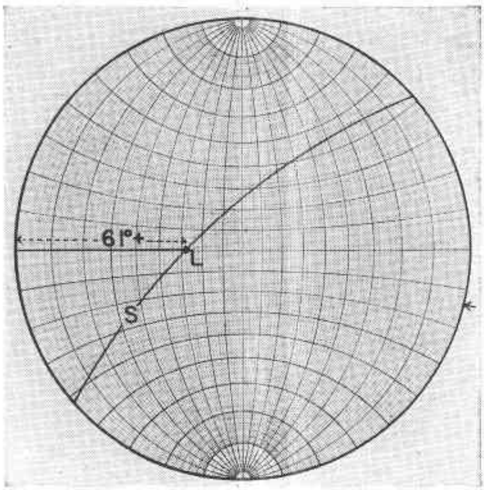

FIG. 3. Method of determining the angle of pitch of the lineation represented in Fig. 1.

While this method is more accurate than the other in many instances, it has the added disadvantages of requiring a third measurement, which must be made with a protractor, and of requiring a graphic solution. Besides taking more time, it does not give final measurements for comparison in the field.

A simple arrangement (Fig. 4) for reading the direction and angle of pitch with a single placing of the compass can save much time in taking a series of lineation measurements. It consists of a compass mounted with a graduated semicircle that is weighted so that it remains vertical; the compass is provided with a weighted pointer that keeps it horizontal. This arrangement is swung on pivots in a frame that has a straight edge that can be placed on, or parallel to, a linear structure in the field. Direction of pitch is read on the compass, and angle of pitch is read on the vertical circle.

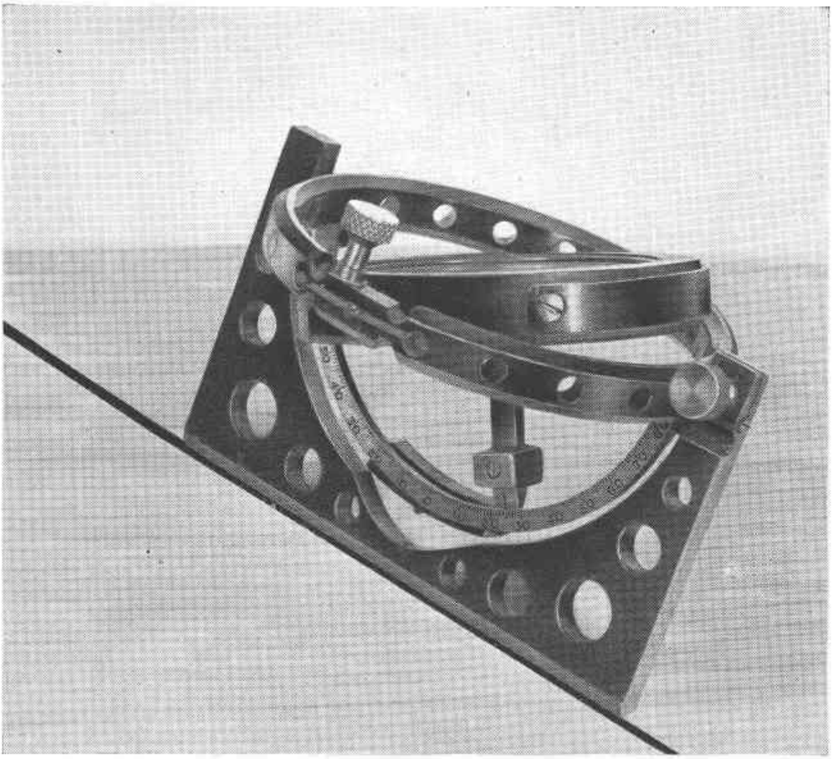

FIG. 4. Apparatus ("universal compass") for measuring geographic coordinates of a linear structure in three dimensions with a single placing of the compass.

The apparatus can be used on overhanging surfaces (Fig. 5) and on outcrops where no planar structure is apparent just as well as on the more commonly encountered type of outcrop. It was tried out underground by Mr. Glenn Waterman of the Idaho Maryland Mines Corporation, who reported that it was difficult to make readings above eye level, and suggested that a transparent bottom on the compass case would allow readings to be made from below without moving the instrument or using a mirror.

Dip and strike of a plane can be determined by measuring the dip just as a lineation is measured, and taking the direction normal to the direction of pitch as the strike of the planar structure. The vertical

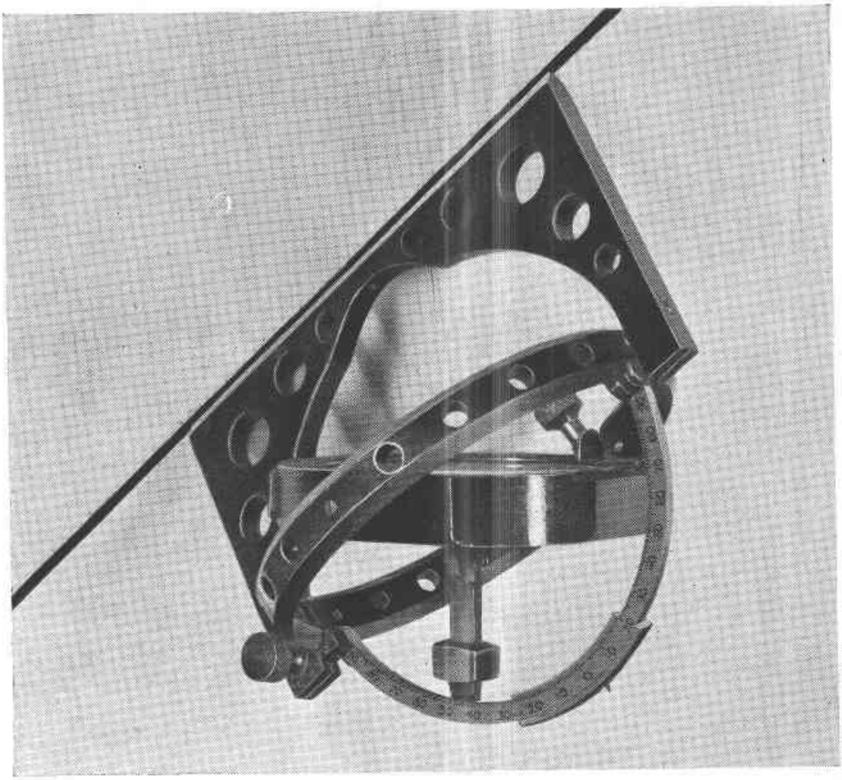

FIG. 5. Use of "universal compass" on an overhanging surface.

circle and weighted pointer are hinged so that the apparatus folds up and can be placed in a case no thicker and not much longer than that of an ordinary Brunton compass.