Know Your Angles

GEORGANN LUCARIELLO

On topographic maps, three different "norths" are shown in the marginal information: True North is the geographic North Pole; Grid North is the orientation of the map to the North Pole; and Magnetic North is the direction in which the north-seeking arrow on a compass points —that is, where the magnetic lines of force converge.

There is a difference in orientation between Grid North and True North, called grid convergence, because the cartographer has to display a spherical image on a flat map sheet. This is usually a small difference and not of any concern to soldiers or land navigators.

When using a map and compass to navigate, the two norths that are of primary concern are Grid North and Magnetic North. The reason this is important is that, while navigating, a soldier must compensate for the difference between the north designated on the map (Grid North) and the compass bearing (Magnetic North). The difference between these two norths is the grid-to-magnetic angle (G-M angle), or declination.

In North America, the magnetic declination varies from 30 degrees east in Alaska to 30 degrees west in Labrador, with a zero declination running roughly from Lake Michigan to the Atlantic Coast in upper Georgia (Figure 1). Magnetic North changes yearly because of the constantly changing magnetic fields on earth —atmosphere, continental shifts, and the like. Thus, the G-M angle also changes.

Virtually all land navigation classes include instruction on how to convert the G-M angle. As a helpful reminder, the conversion instructions are printed near the declination diagram on most Defense Mapping Agency maps. For a westerly declination, to convert magnetic to grid, a soldier subtracts the G-M angle; to convert from grid to magnetic, he adds the G-M angle. For an easterly declination, on the other hand, a soldier adds the G-M angle to convert from magnetic to grid and subtracts to convert from grid to magnetic.

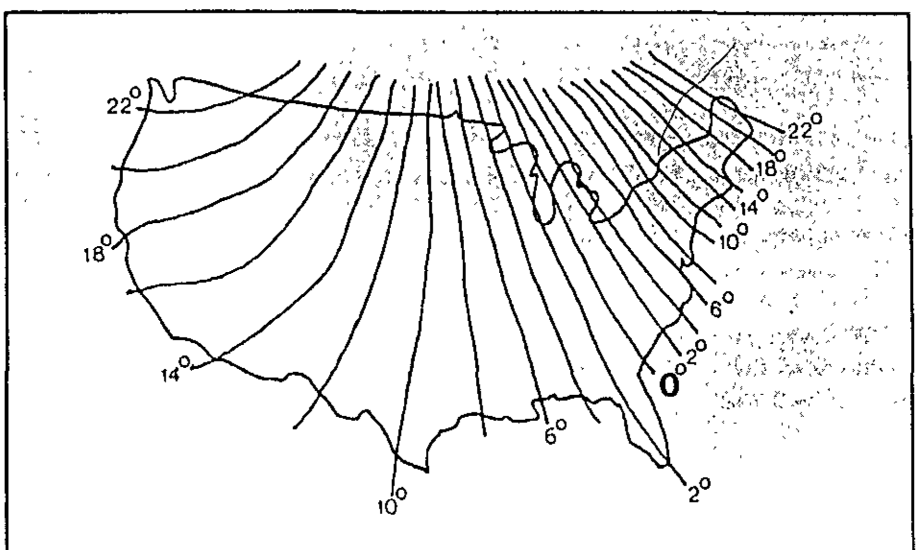

Figure 1

The problem is that the maps used during land navigation instruction do not always carry the most current declination information. Although the map printing date may be current, the declination can be (and often is) outdated by 5 to 20 years.

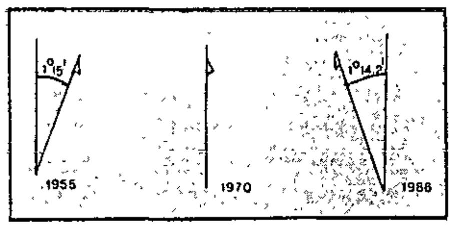

Figure 2

For example, the Tenino map, which is used at Fort Benning for instructional purposes, displays a declination diagram for 1975 when the G-M angle was 21 degrees east. In 1986 the declination was 19 degrees, 56.9 minutes east. For Fort Bliss, the 1980 G-M angle was 11 degrees, 30 minutes east, but the 1986 declination was 10 degrees, 27 minutes east.

A more dramatic change is illustrated if the Fort Benning/Columbus (Georgia) map sheets are compared. In 1955 the declination was 1 degree, 15 minutes east, yet by 1970 there was no difference between the grid and magnetic angles; that is, the Magnetic North had shifted 1 degree, 15 minutes east. Although there is a 1 degree, 15 minute difference between these two declinations, both are now being used for instructional purposes. This constitutes a problem because in 1986 there was actually a 1 degree, 14.2 minute westerly declination (see Figure 2). It is even more of a problem when instructors tell students to ignore the G-M angle when navigating because the change is so small.

By itself, failing to account for a declination of 1 degree, 14.2 minutes does not seem a serious problem. For a 1,000-meter (one kilometer) distance, however, being one degree off target will cause a soldier to deviate 17 meters to the left or right of his intended goal. Over a distance of five kilometers, he would be 85 meters off target—and probably lost.

Now add to this discrepancy the Army's built-in error tolerance. The Soldier's Manual of Common Tasks, Skill Level 1 (October 1985), Task 071-329-1003 (Determine a Magnetic Azimuth Using a Compass), allows a three-degree error for the compass-to-cheek method and a ten-degree error for the centerhold method. When a soldier starts to move, and assuming the error is in the same direction as the declination, the soldier who was 85 meters off target traveling 5 kilometers may now be as much as 340 meters away from the target (compass-to-cheek) or, even more catastrophic, 935 meters away from the target (centerhold). This error is magnified even more if the compass manufacturing tolerance of plus or minus two degrees is added (Stocker and Yale specifications). Thus, even staying within accepted Army standards, the soldier might be as far as 510 meters and 1,105 meters off target, respectively.

Task 071-329-1009 (Navigate From One Point on the Ground to Another Point, Dismounted) would result in similar errors. Luckily for the soldier, the error is not as consistent as the example portrays.

In short, soldiers are taught how to convert Grid North to Magnetic North and vice versa, and then they are told to ignore this when navigating in areas where the declination is perceived to be minimal (as it is at Fort Benning). Instructors need to be aware of the date on the maps they are using and, even more important, of the declination date. They also need to remember that declination does change and must be updated. They need to teach this to their students, and then the soldiers need to be allowed to practice converting and using the G-M angle.

Georgann Lucariello is a research psychologist assigned to the Land Navigation Team, Army Research Institute, Fort Benning Field Unit. She holds a doctorate from Florida State University and has had an article on land navigation published in *Army Trainer* magazine.

Mortar Fire Control

WARRANT OFFICER-2 P.C. HALL, BRITISH ARMY

Modern technology has come to the U.S. Army's mortarmen in the form of the MBC — the M23 Mortar Ballistic Computer. (See "Mortar Ballistic Computer," by Sergeant First Class John E. Foley, INFANTRY, September-October 1986, pages 40-42.) I wonder, though, whether the M16 plotting board is still needed as a back-up plotting system. After all, recent field tests by the U.S. Army Infantry Board with 12 MBCs resulted in the MBCs' obtaining a 98.5% availability rate with a maximum achieved availability rate of 99.5%.

Most FDC sections are authorized two MBCs (cavalry units have one per tube). Therefore, with four reliable MBCs in each platoon, there seems little need to have any back-up system at all; nevertheless, it is probably wise to have one to meet unexpected emergencies.

A simple back-up system is readily available. It consists of a map, a protractor, and a firing table — the same system we have been using for years as a back-up to our plotting board.

The map, protractor, and firing table method of acquiring firing data is easy to teach and learn. Although some special missions are difficult to accomplish using this method, with practice, there is no reason why these cannot be mastered as quickly as any other missions.

METHOD

Obtaining the data for a fire mission using this method is very basic: For example, the mortar location and the target are plotted; the distance between the plots is determined using the protractor; the corresponding charge and elevation are found from the firing table. Again, the protractor is used to determine the azimuth from the mortar to the target. The mortar is laid on the azimuth by use of the aiming circle or the M2 compass. Then, as is normal, the aiming posts are placed out on a referred deflection. Corrections from the forward observer (FO) are quickly and easily incorporated by drawing a straight line from the observer's location to the target. The roamer on the protractor is used to measure the correction in relation to the observer-target (OT) line and a new plot is made. Once the firing data to engage the target has been gathered, it is a simple task to convert the azimuth gained from the map to its corresponding deflection by using the LARS (left add, right subtract) rule.

It seems to me that it would be a waste of time to train the students in mortar