

**University of Anbar**  
**College of Science**  
**Department of Applied Geology**

**Field Geology**  
**Title of the lecture**  
**Attitudes of Lines and Planes**

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## Attitudes of Lines and Planes

This lecture is concerned with the orientations of lines and planes. The structural elements that we measure in the field are mostly lines and planes, and manipulating these elements on paper or on a computer screen helps us visualize and analyze geologic structures in three dimensions. In this lecture we will examine several graphical and mathematical techniques for solving apparent-dip problems. Each technique is appropriate in certain circumstances. The examination of various approaches to solving such problems serves as a good introduction to the techniques of solving structural problems in general. Finally, many of these problems are designed to help you visualize structural relations in three dimensions, a critical skill for the structural geologist. The following terms are used to describe the orientations of lines and planes. All of these are measured in degrees, so values must be followed by the ° symbol.

**Attitude:** The orientation in space of a line or plane. By convention, the attitude of a plane is expressed as its strike and dip; the attitude of a line is expressed as trend and plunge.

**Bearing:** The horizontal angle between a line and a specified coordinate direction, usually true north or south; the compass direction or azimuth.

**Strike:** The bearing of a horizontal line contained within an inclined plane (Fig. 1.1). The strike is a line of equal elevation on a plane. There are an infinite number of parallel strike lines for any inclined plane.

**Dip:** The vertical angle between an inclined plane and a horizontal line perpendicular to its strike.

**Dip direction:** The direction of dip can be thought of as the direction water would run down the plane (Fig. 1.1).

**Trend:** The bearing (compass direction) of a line (Fig. 1.2). Non-horizontal lines trend in the down-plunge direction.

**Plunge:** The vertical angle between a line and the horizontal (Fig. 1.2).

**Pitch:** The angle measured within an inclined plane between a horizontal line and the line in question (Fig. 1.3). Also called rake.

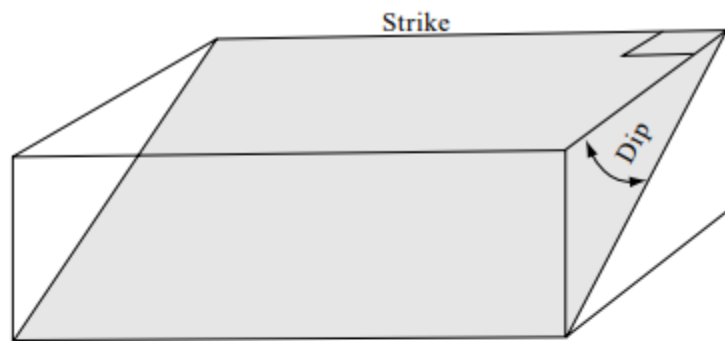


Figure 1: Strike and dip of a plane.

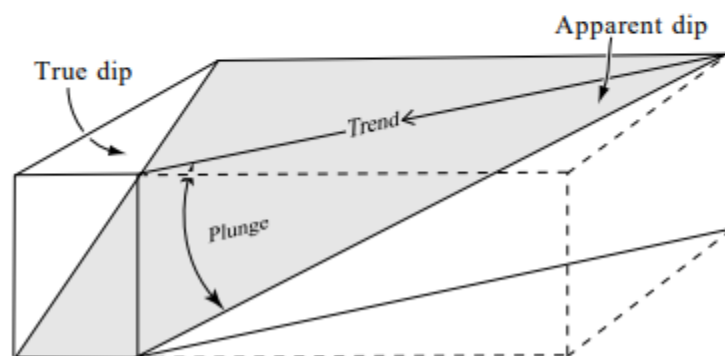


Figure 2: Trend and plunge of an apparent dip.

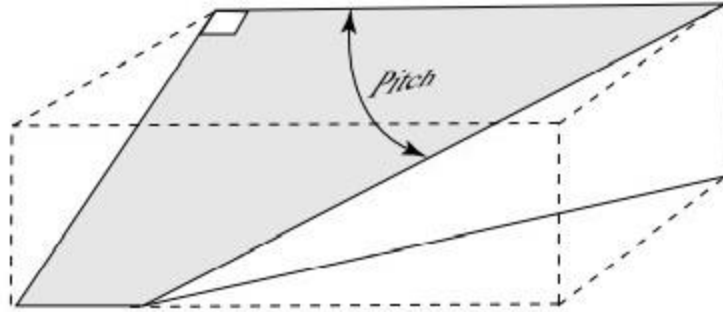


Figure 3: Pitch (or rake) of a line in an inclined plane.

**Apparent dip:** The vertical angle between an inclined plane and a horizontal line that is not perpendicular to the strike of the plane (Fig. 1.2). For any inclined plane (except a vertical one), the true dip is always greater than any apparent dip. Note that an apparent dip may be defined by its trend and plunge or by its pitch within a plane.

There are two ways of expressing the strikes of planes and the trends of lines (Fig. 1.4). The azimuth method is based on a  $360^\circ$  clockwise circle; the quadrant method is based on four  $90^\circ$  quadrants. A plane that strikes northwest–southeast and dips  $50^\circ$  southwest could be described as  $315^\circ$ ,  $50^\circ$ SW (azimuth) or N $45^\circ$ W,  $50^\circ$ SW (quadrant). Similarly, a line that trends due west and plunges  $30^\circ$  may be described as  $30^\circ$ ,  $270^\circ$  (sometimes written as  $30^\circ \rightarrow 270^\circ$ ) or  $30^\circ$ , N $908^\circ$ W. For azimuth notation, always use three digits (e.g.,  $008^\circ$ ,  $065^\circ$ ,  $255^\circ$ ) so that a bearing cannot be confused with a dip (one or two digits). In this book, the strike is given before the dip, and the plunge is given before the trend. To ensure that you become comfortable with both azimuth and quadrant notation, some examples and problems use azimuth and some use quadrant. However, we strongly recommend that you use the azimuth convention in your own work. It is much easier to make errors reading a bearing in quadrant notation (two letters and a number) than in azimuth notation (a single number). In addition, when entering orientation data into

a computer program or spreadsheet file, it is much faster to enter azimuth notation because there are fewer characters to enter.

Notice that because the strike is a horizontal line, either direction may be used to describe it. Thus, a strike of N45°W (315°) is exactly the same as S45°E (135°). In quadrant notation, the strike is commonly given in reference to north (N45°W rather than S45°E). In azimuth notation the “right-hand rule” is commonly followed. The right-hand rule states that you choose the strike azimuth such that the surface dips to your right. For example, the attitude of a plane expressed as 040°, 65°NW could be written as 220°, 65° using the right-hand rule convention because the 65°NW dip direction would lie to the right of the 220° strike bearing. The dip, on the other hand, is usually not a horizontal line, so the down-dip direction must somehow be specified. The safest way is to record the compass direction of the dip. Because the direction of dip is always perpendicular to the strike, the exact bearing is not needed; the dip direction is approximated by giving the quadrant in which it lies or the cardinal point (north, south, east, or west) to which it most nearly points. If the right-hand rule is strictly followed, it is possible to specify the dip direction without actually writing down the direction of dip.

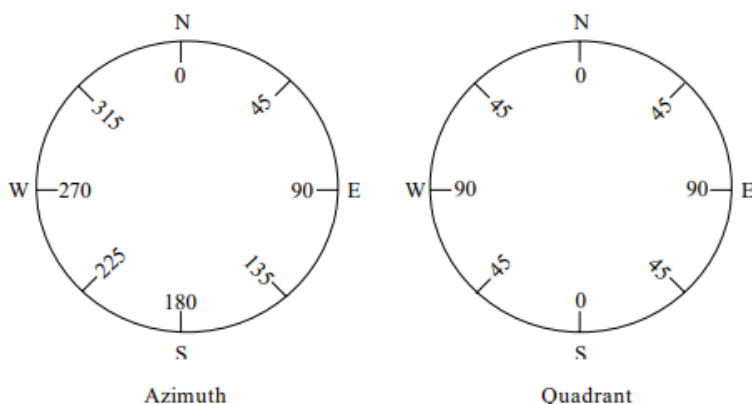


Figure 4: Azimuth and quadrant method of expressing compass directions.

**Problem 1:** Translate the azimuth convention into the quadrant convention, or vice versa.

- |          |          |
|----------|----------|
| a) N12°E | f) N37°W |
| b) 298°  | g) 233°  |
| c) N86°W | h) 270°  |
| d) N55°E | i) 083°  |
| e) 126°  | j) N3°W  |

**Problem 2:** Circle those attitudes that are impossible (i.e., a bed with the indicated strike cannot possibly dip in the direction indicated).

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|-----------------|-----------------|
| a) 314°, 49°NW  | f) 333°, 15°SE  |
| b) 086°, 43°W   | g) 089°, 43°N   |
| c) N15°W, 87°NW | h) 065°, 36°SW  |
| d) 345°, 62°NE  | i) N65°W, 54°SE |
| e) 062°, 32°S   |                 |

## References

Stephen M. Rowland, Las Vegas Ernest M. Duebendorfer, and Ilsa M. Schiefelbein, (2007) Structural Analysis and Synthesis, A Laboratory Course in Structural Geology. Third Edition