Introduction to Rock Mass Classifications

Discontinuities, Intact rock, and Rock mass

OUTCROP DESCRIPTION

1. Orientation

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Discontinuities

Discontinuity is a general term for any mechanical break that has zero or relatively low tensile strength, it is a collective term that includes features such as joint (a barren closed discontinuity on which no measurable slip is observed), vein (a discontinuity in which visible mineral infill took place), fissure (a discontinuity with a void space), fault (a discontinuity along which a detectable slip has occurred), and bedding plane (a discontinuity that separates the adjacent rock beds). The discontinuities strongly affect the mechanical and hydrological properties of a rock mass, in terms of its strength, deformability, stability, porosity, and permeability, accordingly, the discontinuities play a major role in the design and safety of civil works and the occurrence and movement of groundwater and hydrocarbons. There are many fields and laboratory parameters that can be used to evaluate any site under study. The type of these parameters depends on the purpose of the study.

The term "discontinuity" applies to any distinct break or interruption in the integrity of a rock mass. Discontinuities are classified as either stratigraphic or structural, according to their mode of formation.

(1) Stratigraphic discontinuities

Stratigraphic discontinuities can be either depositional or erosional. They represent a significant interruption of the orderly sequence of deposition, most frequently marked by a considerable time interval of erosion or non-deposition. The bedding planes above and below the disconformity are usually parallel. These features can be found in all stratified sedimentary rocks, most volcanic flows, and some low-grade metamorphic rocks. Zones of weathering or alteration may also be considered discontinuities.

(2) Structural discontinuities

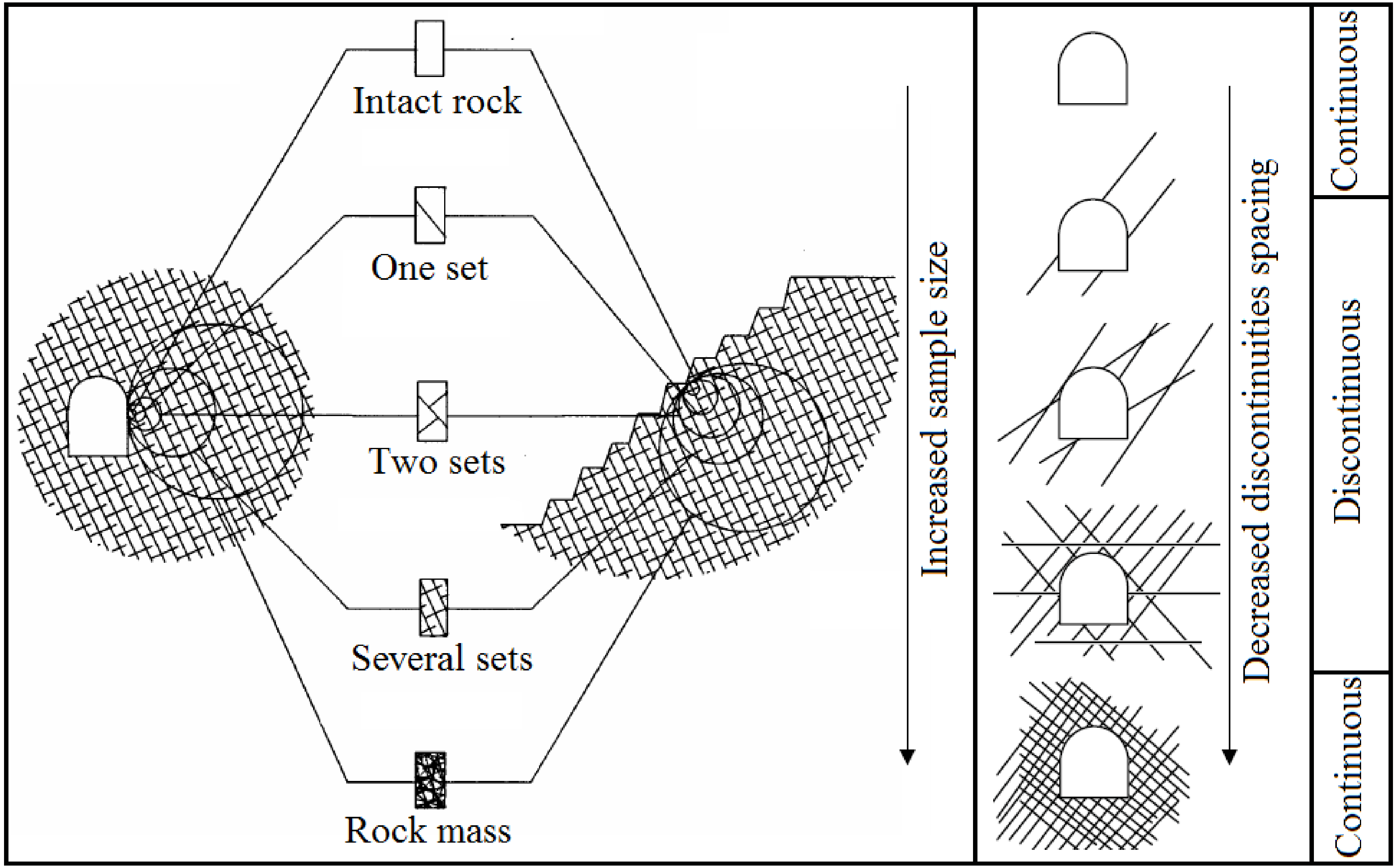
Structural discontinuities develop after the initial formation of the rock mass as a result of external processes acting on it. These features are produced by the mechanical deformation or displacement of rock by natural stresses within the Earth's crust. They include fractures of all types, planes or zones of weakness, faults, and shear zones, most of which have little to no tensile strength.

The deformation of rock falls into three broad categories: elastic, plastic, and fracture deformation. Elastic deformation is deformation from which the rock mass instantaneously recovers its original shape on removal of the external forces acting on it. The passage of earthquake waves or tidal stresses may cause elastic deformation. Since no permanent structural discontinuities are produced by elastic deformation, this chapter addresses discontinuities associated only with plastic and fracture deformation.

Plastic deformation exceeds the strain limit for elastic deformation and results in a permanent change in the shape of the rock mass. Folds, foliations (such as schistosity and gneissosity), and other linear and planar structures result. The orientation of such features is related to flowage and grain rotation accompanying compression and shearing forces, which ultimately lead to metamorphism.

INTACT ROCK

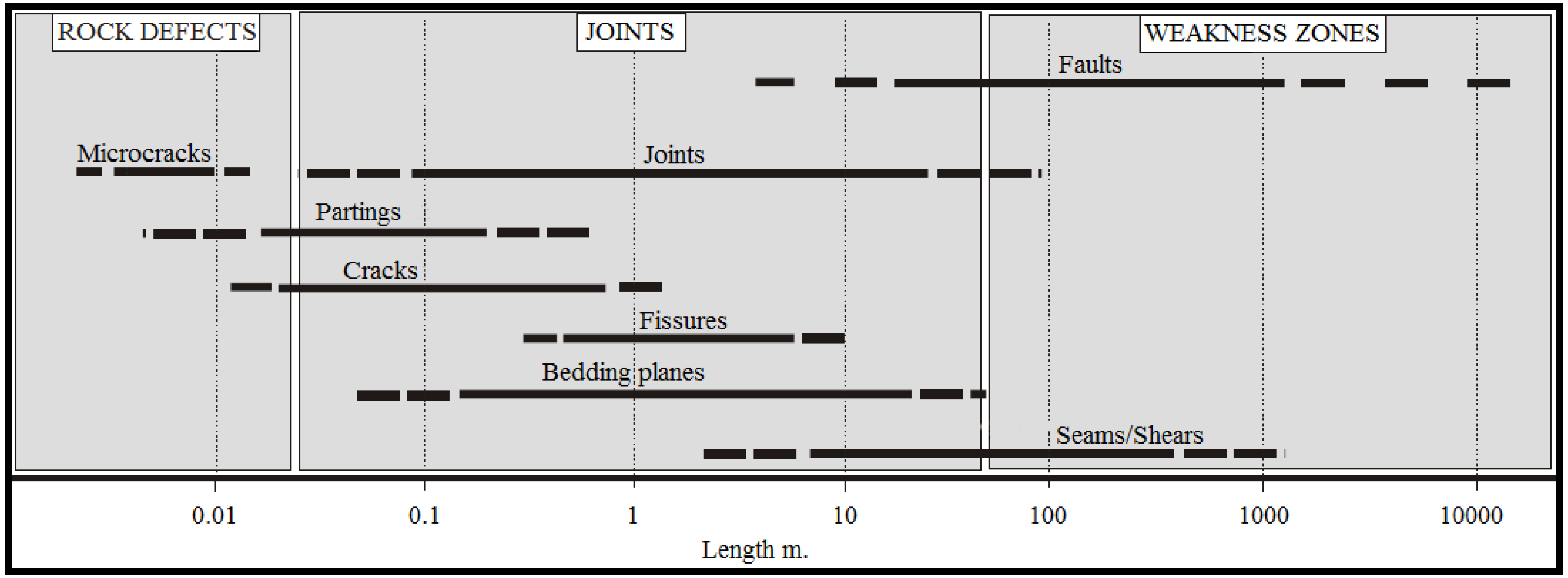
Most of the index and mechanical properties are determined by intact rocks. These properties depend on the constituent minerals and the type of mineral bonding. The properties of rock material are determined from tests of intact hand specimens, which have no defects. Intact rocks may range from a few millimeters to several meters in size. The results are applicable to small hand specimens and representative samples of intact rock material, which is considered continuous. They do not account for the influence of discontinuities or boundary conditions of the rock. Otherwise, highly fractured rocks make continuous boundary conditions in a rock mass. The grain size of carbonate rocks was carried out by assaying the rock surface and the polished samples by eye and lens. Microscopic study awards the best thought for grain size and texture. Soil mechanics tests were done on clastic rocks for classifying them as rock mass.



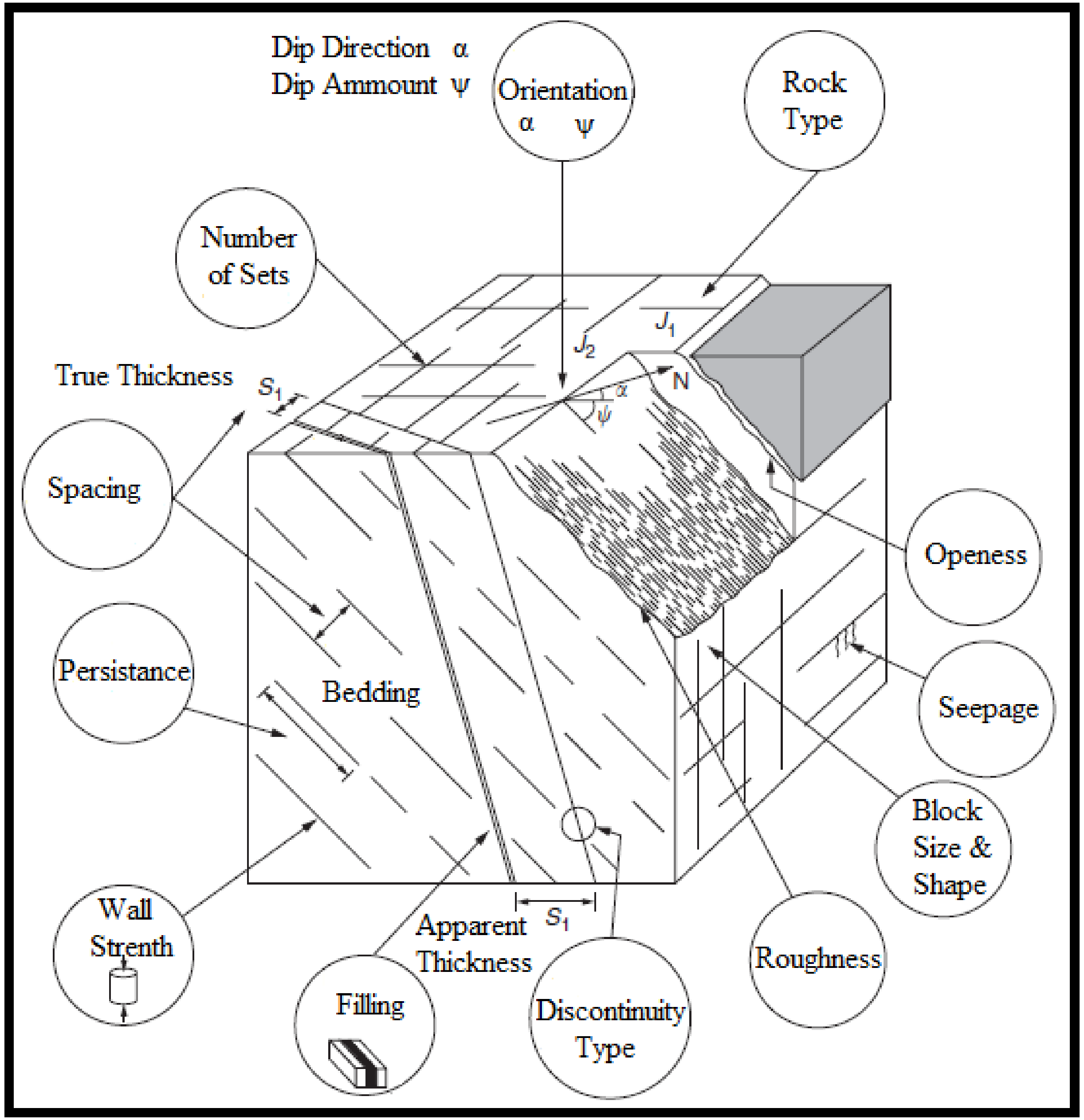
Simplified representation of the influence of scale and spacing on the continuity and the type of rock mass behavior model which should be used in designing underground excavations or rock slopes

ROCK MASS

Structural breaks or discontinuities cover all types of structural weakness that generally control the mechanical behavior of rock masses. The rock mass is continuously or discontinuous comprised of intact blocks of rock separated by discontinuities such as joints, bedding planes, veins, faults, or sheared decomposed and disintegrated zones (Figure 2.2). Discontinuities type and attitude are the skeletons of rock structure. Most engineering problems relate to discontinuities rather than to rock type or intact rock strength.



OUTCROP DESCRIPTION



OUTCROP DESCRIPTION

1. Orientation: **Attitude of discontinuity in space. Described by the dip direction (azimuth) and dip of the line of steepest declination in the plane of the discontinuity. Example: dip direction/dip (015°/35°).**

2. Spacing: **Perpendicular distance between adjacent discontinuities. Normally refers to the mean or modal spacing of a set of joints.**

3. Persistence: **Discontinuity trace length as observed in an exposure. May give a crude measure of the areal extent or penetration length of a discontinuity. Termination in solid rock or against other discontinuities reduces the persistence.**

4. Roughness: **Inherent surface roughness and waviness relative to the mean plane of a discontinuity. Both roughness and waviness contribute to the shear strength. Large-scale waviness may also alter the dip locally.**

5. Wall Strength: **Equivalent compression strength of the adjacent rock walls of a discontinuity. May be lower than rock block strength due to weathering or alteration of the walls. An important component of shear strength is if rock walls are in contact.**

OUTCROP DESCRIPTION cont.

6. Aperture: Perpendicular distance between adjacent rock walls of a discontinuity, in which the intervening space is air or water-filled.

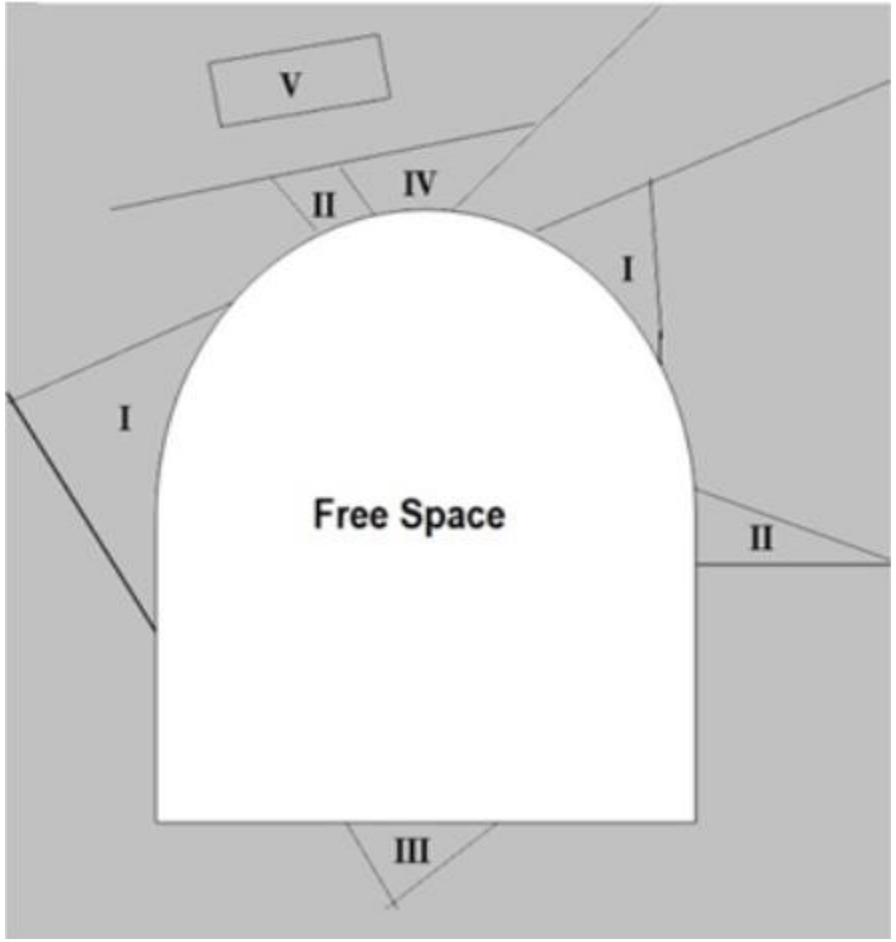
7. Filling: Material that separates the adjacent rock walls of a discontinuity and that is *usually* weaker than the parent rock. Typical filling materials are sand, silt, and clay. Also includes thin mineral coatings and healed discontinuities, e.g. quartz and calcite veins.

8. Seepage Water: flow and free moisture visible in individual discontinuities or in the rock mass as a whole.

9. Number of Sets: The number of joint sets comprising the intersecting joint system. The rock mass may be further divided by individual discontinuities.

10. Block Size: Rock block dimensions resulting from the mutual orientation of intersecting joint sets, and resulting from the spacing of the individual sets. Individual discontinuities may further influence the block size and shape

ORIENTATION



1. Type I being moveable.
2. Type II having key potential to move.
3. Type III has no movement because of its position in basement.
4. Type IV has no movement because of blocking with around blocks.
5. Type V a jointed block without any free space in rock mass.

Brunton Compass

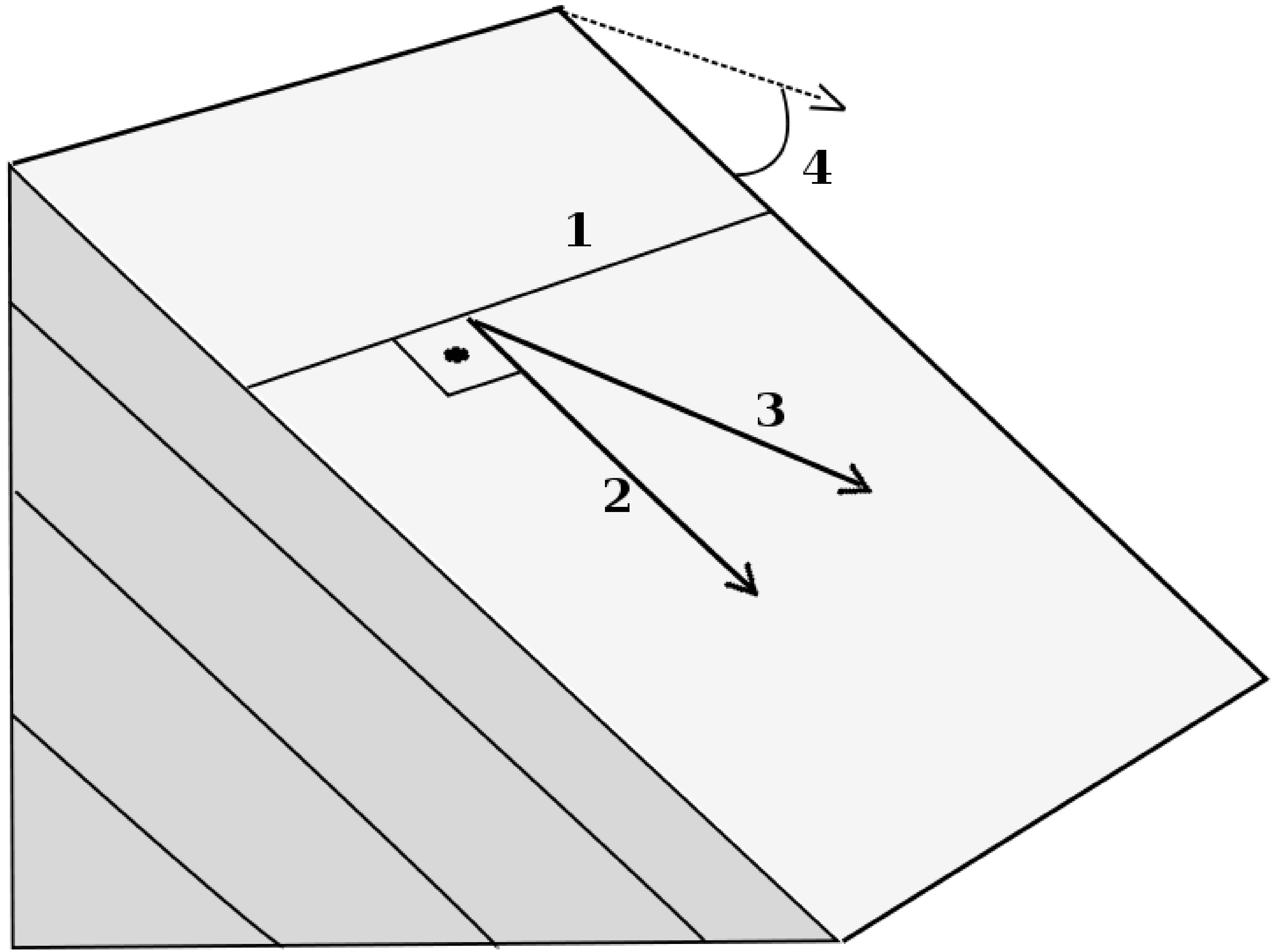
Silva Compass

Clar electronic geological compass

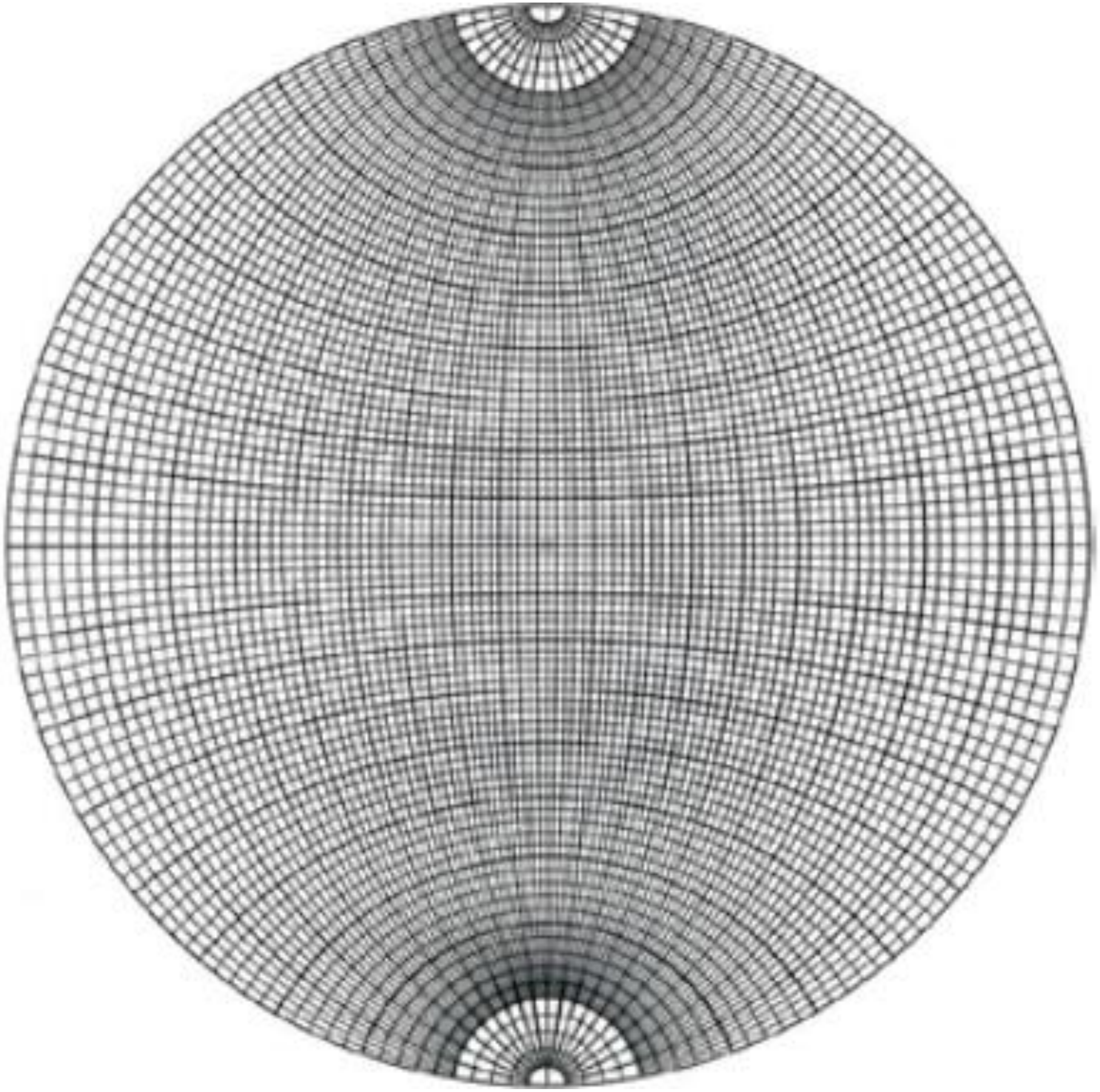
Discontinuity orientation is the attitude of discontinuity in space. It could show grouping into sets (groups of parallel discontinuities that maintain their orientation over a considerable area) and systems (applied to two intersecting discontinuity sets with a relatively fixed angle of intersection).

The discontinuity orientation can be described by the dip of the line of steepest inclination measured, from horizontal, and by the dip direction measured clockwise from true north. Example: dip direction/dip angle (025˚/45˚). Discontinuity (fracture) analysis according to the principal tectonic axes was done to detect the geometrical and genetic relationship with the stresses in the region. Fractures were representative in the form of shear fracture sets (okl, hko, hol, and hkl) and extension fracture sets (ac).

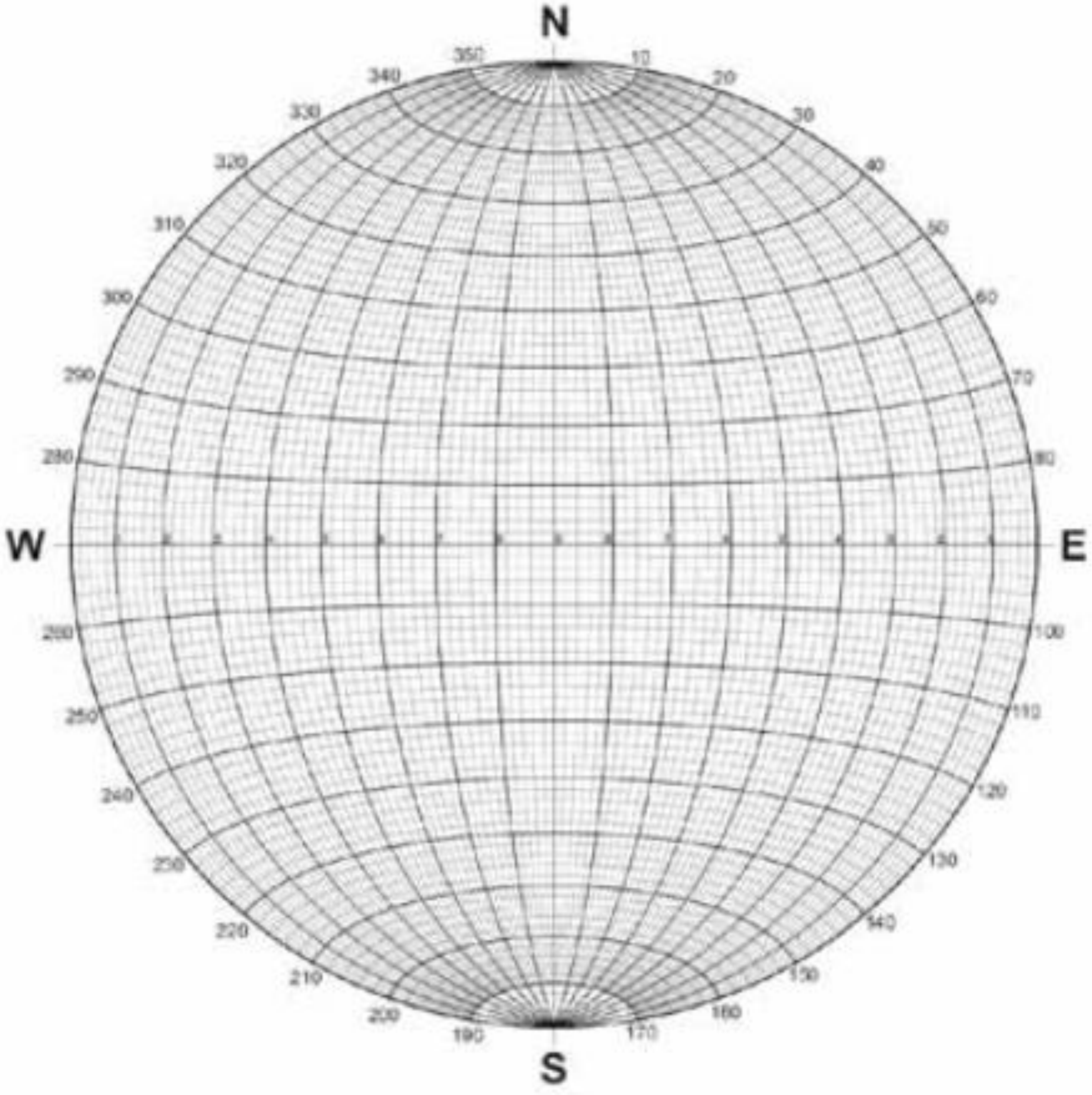
The common discontinuity sets are persistently developed and are characterized by being normal to the bedding, while the less common discontinuity sets are characterized by being inclined at various degrees to the bedding.



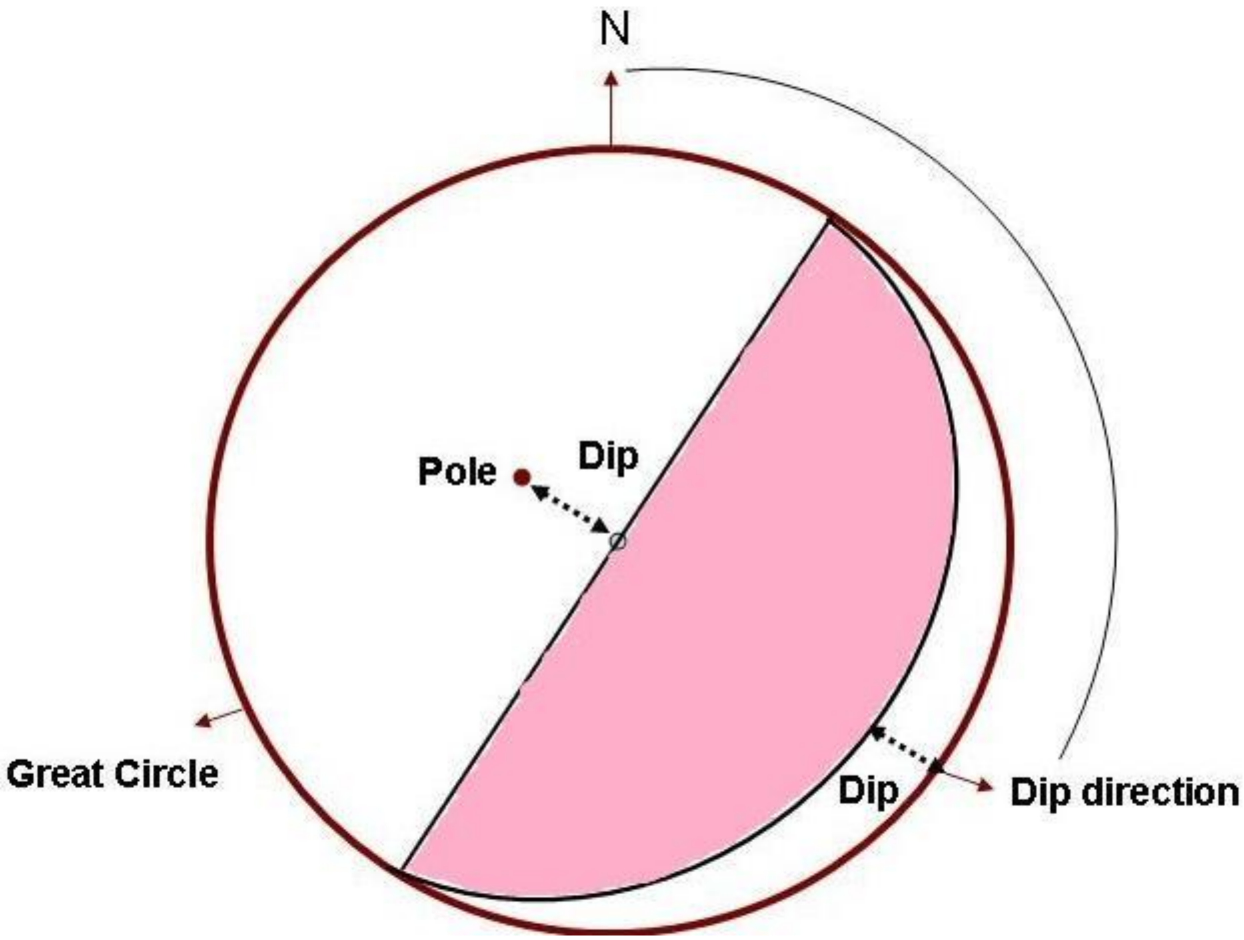
1 Strike 2 Dip direction 3 Apparent dip direction 4 Dip ammount



Wulff net, an equal-angle projection

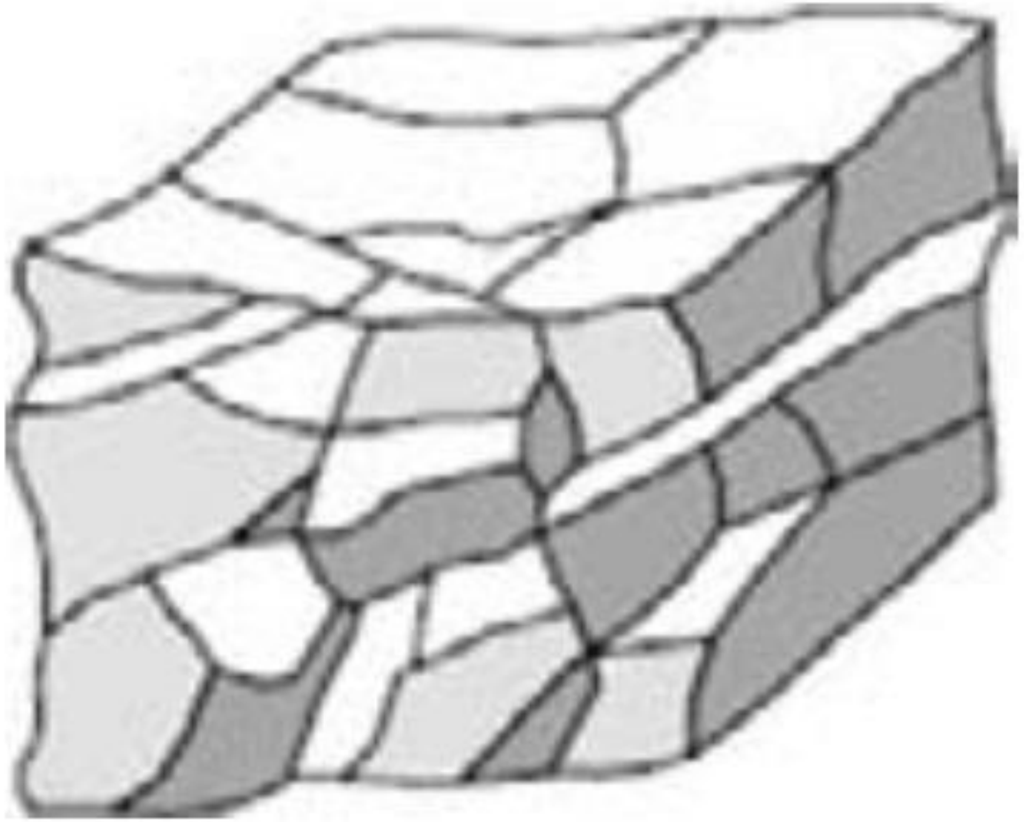


Schmidt net (Lambert projection), an equal-area projection



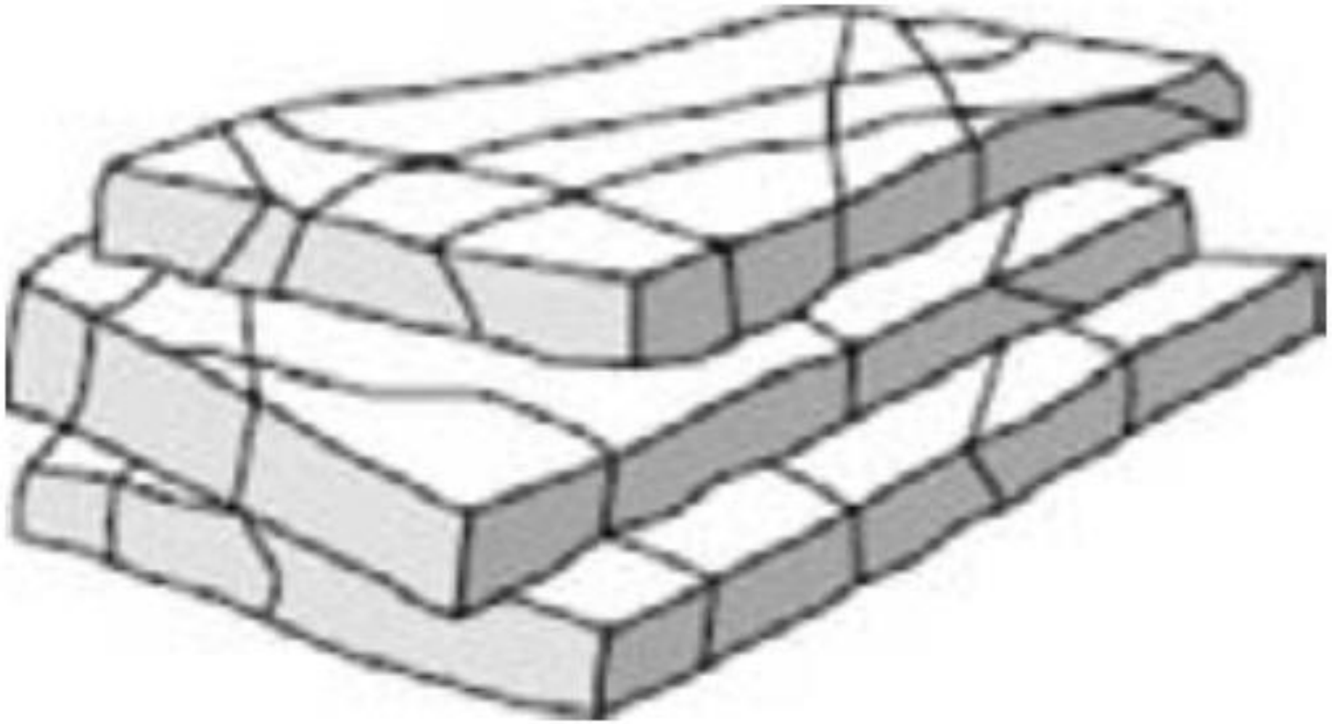
Two-dimensional representations of planes and poles in a horizontal plane.

Polyhedral blocks



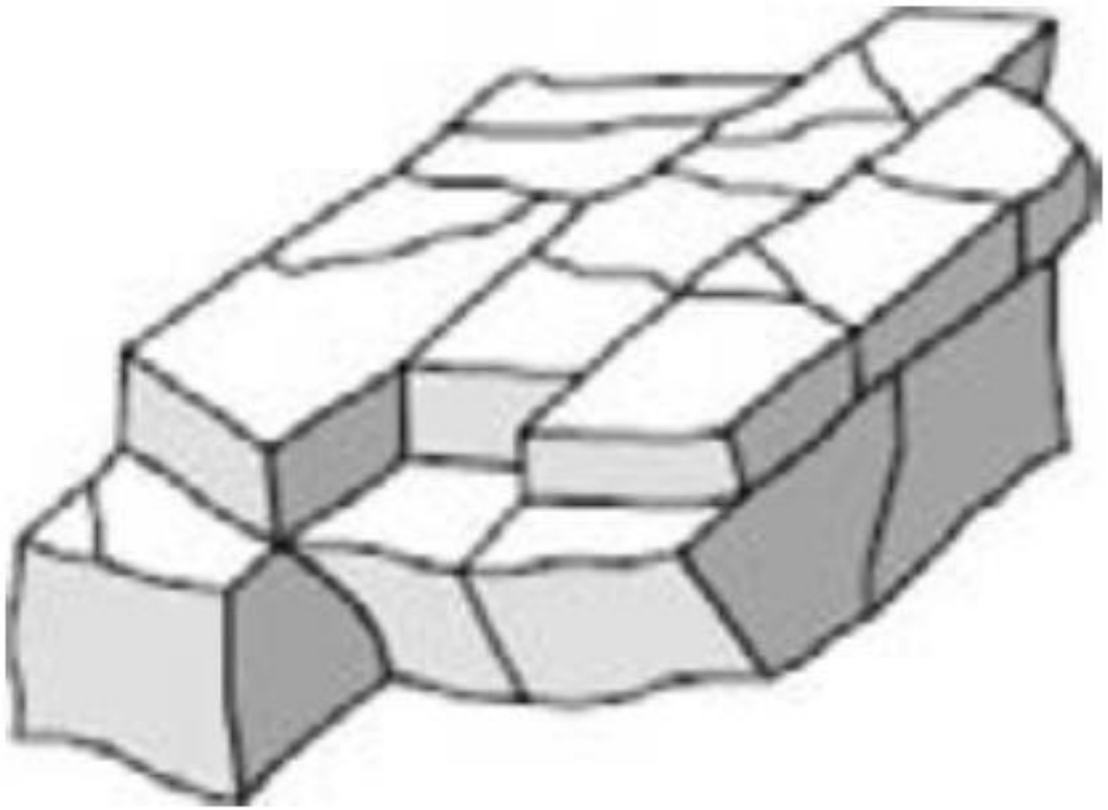
Irregular discontinuities without arrangement into distinct sets, and of small persistence

Tabular blocks



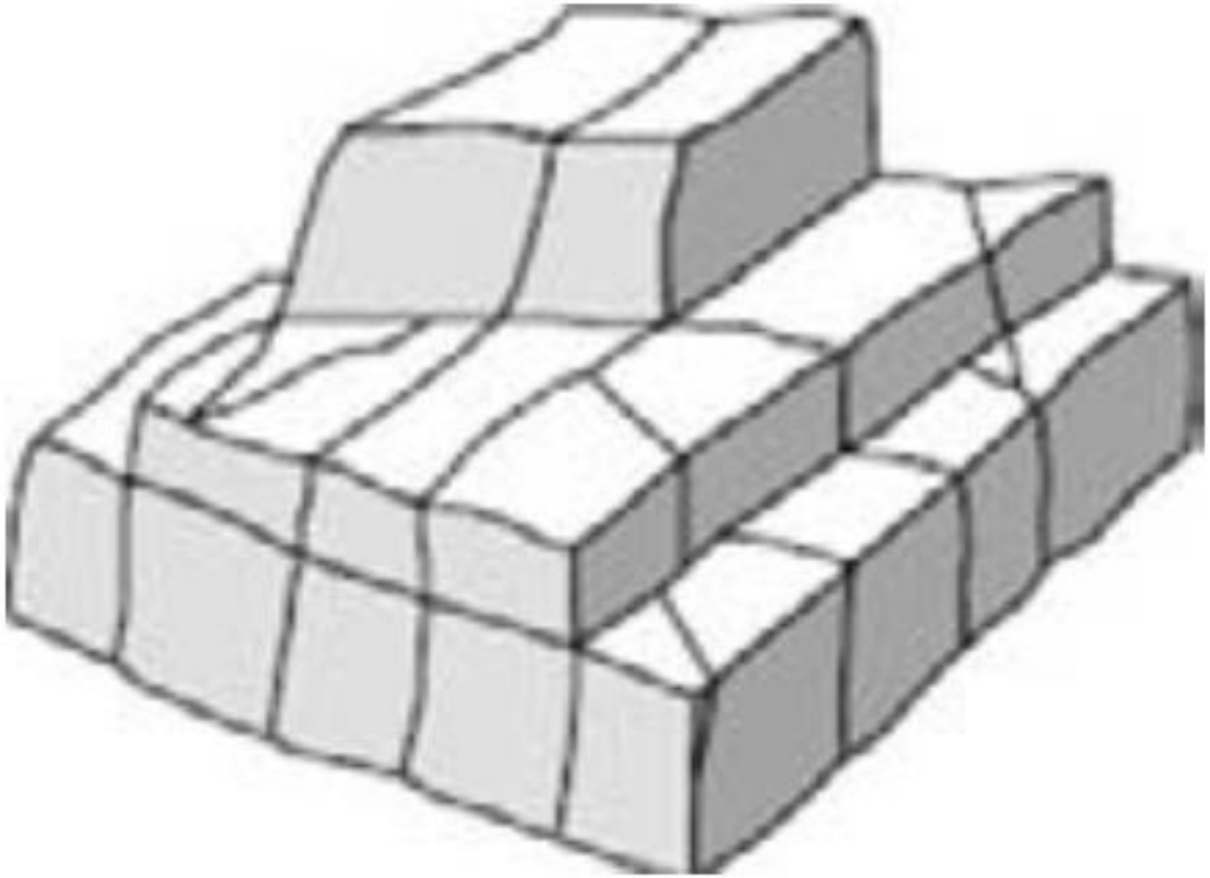
One dominant set of parallel discontinuities, for example, bedding planes, with other non-continuous joints; thickness of blocks much less than length or width

Prismatic blocks



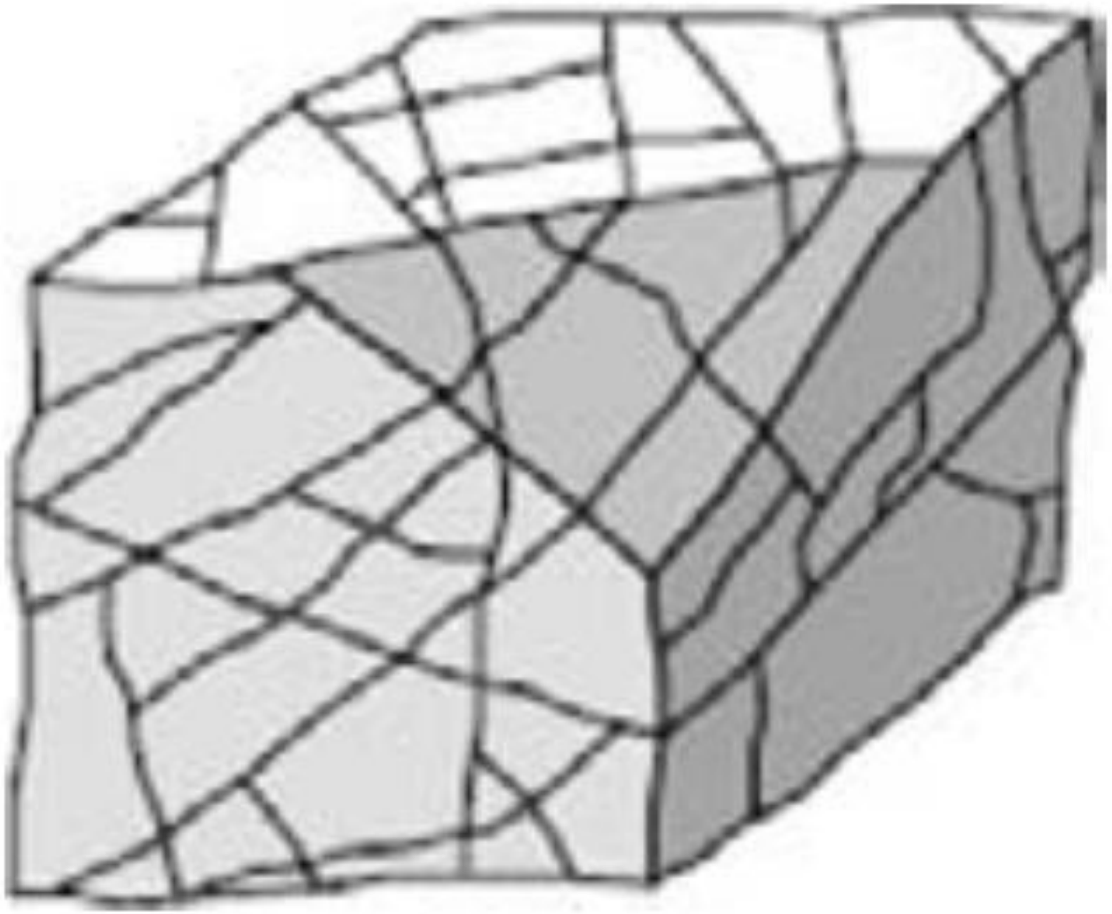
Two dominant sets of discontinuities, approximately orthogonal and parallel, with a third irregular set; thickness of blocks much less than length or width

Equidimensional blocks



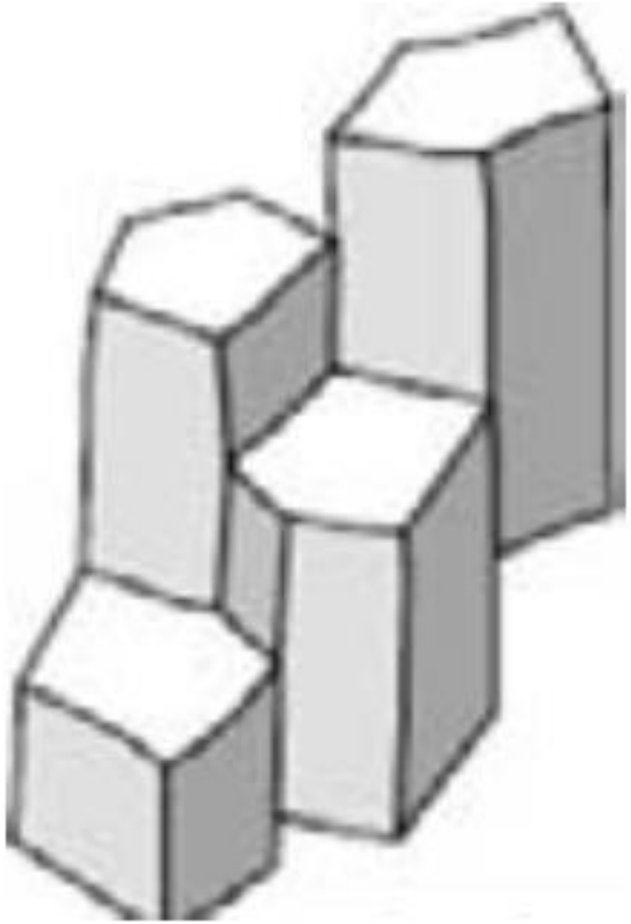
Three dominant sets of discontinuities, approximately orthogonal, with occasional irregular joints, giving equidimensional blocks

Rhombohedral blocks



Three (or more) dominant, mutually oblique, sets of joints, giving oblique shaped, equidimensional blocks

Columnar blocks



Several, usually more than three, sets of discontinuities; parallel joints usually crossed by irregular joints; length much greater than other dimensions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