

University of Anbar
College of Science
Department of Applied Geology

Structural Geology

Title of the lecture

Joints

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Joints

Joints: planes of weakness or mechanical discontinuities in the cohesive masses of rocks with complete lack of movement.

There are two types of joints depend on spatial relations:

Systematic Joints: group of parallel to sub parallel joints and evenly spaced to one another.

Non-Systematic joints: Irregularly oriented joints and no obvious spatial relationship.



Figure (1) Joint in Injana formation, near sheikh Masaud area, 10 km east Ramadi city, Iraq



Figure (2) Two sets of systematic joints in Pila Spi Formation, northeast limb of Safeen Anticline, near shaqlawa city, northeast Iraq

Joint sets: A group of systematic joints.

Joint system: Two or more geometrically related sets of joints at constant angles.

Dihedral angle: Angle between two joint sets in a joint system.

Orthogonal system: Two sets of joints intersect at right dihedral angle, or two sets of joints perpendicular to each other figure 3.

Conjugate system: Two sets of joints intersect at dihedral angle of approximately 60° .



Figure (3) Orthogonal system, here two sets of joints one of them is vertical and the another is horizontal

Strike-parallel joints: Joints that parallel the general trend of fold-hinges in a region of folded strata (i.e., the joints parallel regional bedding strike) figure 4.

Cross-strike joints: Joints that cut across the general trend of fold hinges in a region of folded rocks (i.e., the joints cut across regional bedding strike) figure 4.

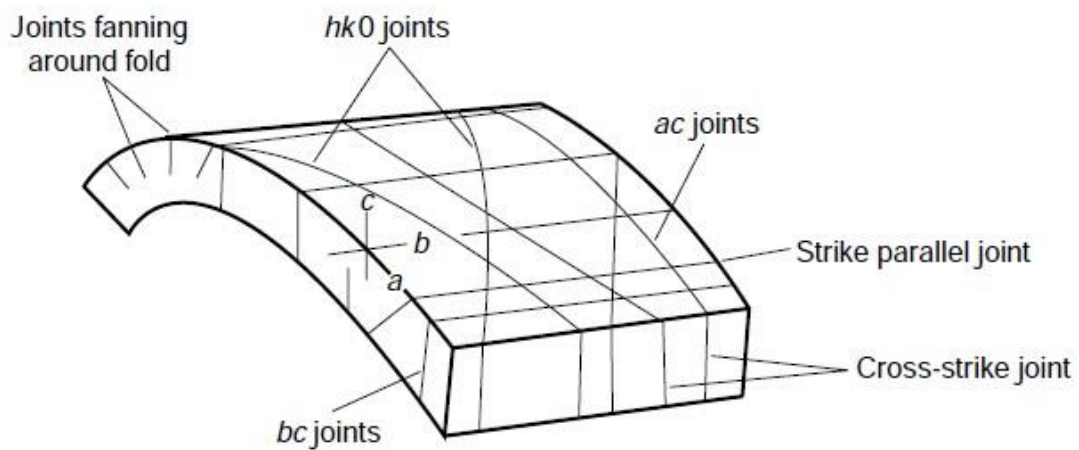


Figure (4) Some types of joints, see the text

Classification of joints

1. Geometrical or tectonic classification of joints

According to three orthogonal tectonic axes (a, b and c) where a-axis is perpendicular to hinge line of the fold and parallel to bedding plane, b-axis is parallel to hinge line and c-axis is perpendicular to plane which contain a and b axes, there are three types of joint sets ab, ac and bc. Each set contains two axes and third axis is perpendicular to joint plane. σ_1 is parallel to joint surface while σ_3 is perpendicular to it.

There are four types of joint systems hko, hol, okl and hkl where h, k and l represent axes a, b, and c respectively. Each joint system intersects two axes and parallel to the third except the last joint system (hkl) intersects the entire tectonic axes figure (4 and 5). σ_1 bisect the acute angle while σ_3 bisect the obtuse angle.

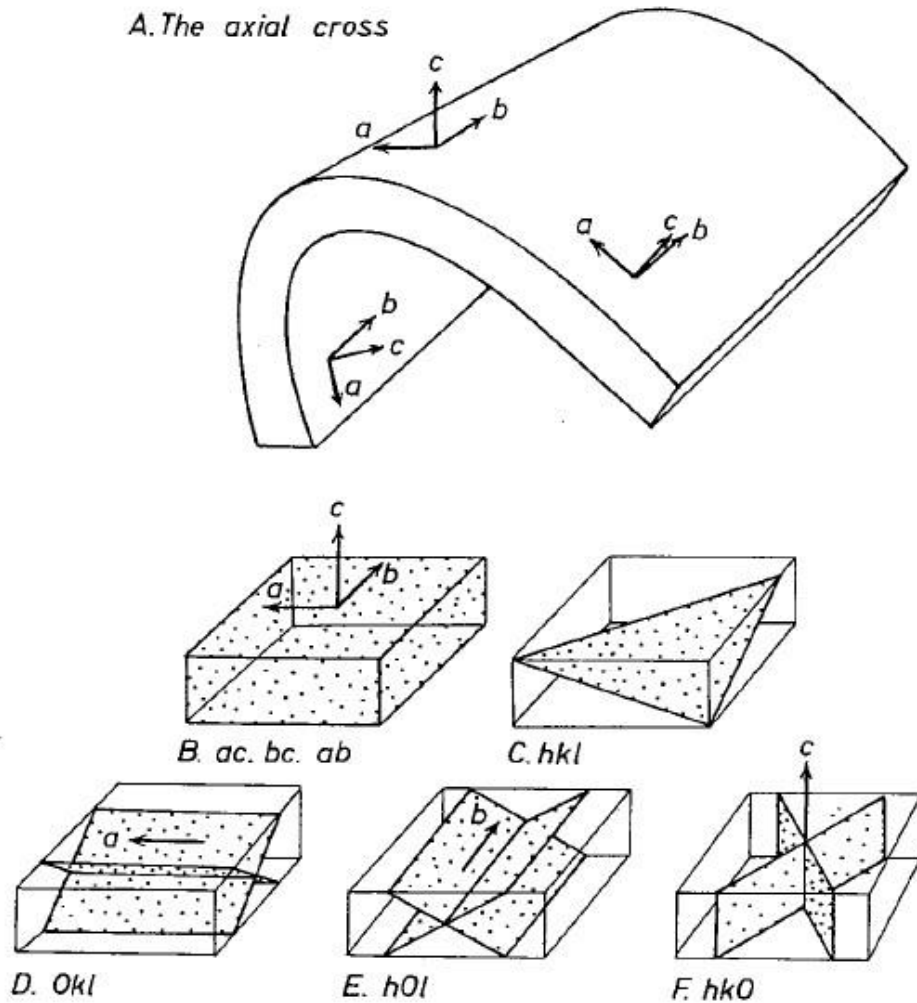


Figure (5) A. Three orthogonal tectonic axes a, b and c. a and c axes are rotation with folding surface while b-axis is parallel to hinge line of the fold. B. Joint sets. C-F Types of joint systems

ab joint set:

Joint planes are parallel to the bedding planes and contains a and b axes while c axis is perpendicular to joint plane.

ac joint set:

Joint planes are perpendicular to bedding plane and hinge line which contains a and c axes while b-axis is perpendicular to joint plane.

bc joint set:

Joint planes are perpendicular to the bedding plane and parallel to the hinge line which contains b and c axes while a-axis is perpendicular to joint plane.

hko joint systems:

Fracture planes of this system are intersecting a and b axes and parallel to c-axis that perpendicular to bedding planes. The system is divided into two subsystems: -

- a. hko acute about a
- b. hko acute about b

hol system:

Fracture planes belong to this system are intersecting a and c axes and parallel to b- axis. The system is divided into:

- a. hol acute about a
- b. hol acute about c

okl system:

Fracture planes of this system are intersecting b and c axes and parallel to a-axis. The system divided to: -

- a. okl acute about b
- b. okl acute about c

hkl system:

Fracture planes of this system are intersecting all the orthogonal tectonic axes a, b and c.

2. Genetic classification of joints: -

Joints classified genetically into two main types, tension joints and shear fractures. Each type has specific processes to develop.

Tension joints:

There are two common types of these joints; the first one is joints parallel to ac joint set, perpendicular to bedding planes and hinge line of the fold.

These joints parallel to maximum principal stress direction figure (6). Usually form at the beginning of folding. The second type of tension joints is parallel to bc joint set and the hinge line, sometime called outer-arc joints or release joints. These joints usually form at the last stage of folding.

Shear fractures:

These fractures represent the joint systems. They develop in different stages of folding. The maximum principal stress axis or direction bisects the acute angle of the joint system or conjugate angle.

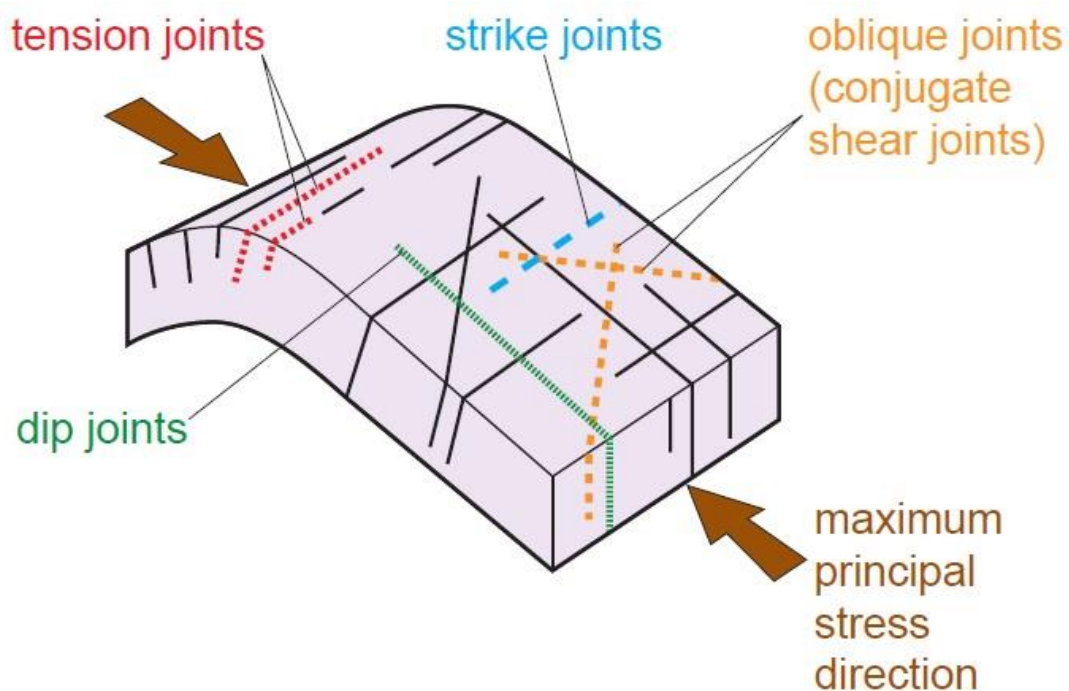


Figure 6: foldig and fracturing relted to maximum principal stress direction.

References

Ben A. van der Pluijm, and Stephen Marshak. (2004) EARTH STRUCTURE AN INTRODUCTION TO STRUCTURAL GEOLOGY AND TECTONICS. Second edition.