CHAPTER 2

Crystallography

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1. Minerals have ordered internal geometric arrangement which means the atoms or molecules are stacked in an ordered fashion.
2. The simplest way to form an ordered two dimensional arrangement is by repeating a spot (say, point a) along a line by moving the spot by set amount in the same direction. The line has a “Translational Symmetry”
3. We can form a mesh by moving the point a to point b at an angle (ɣ) to the line by a set amount and repeating the process. We call this mesh “point lattice” and the points are called lattice nodes

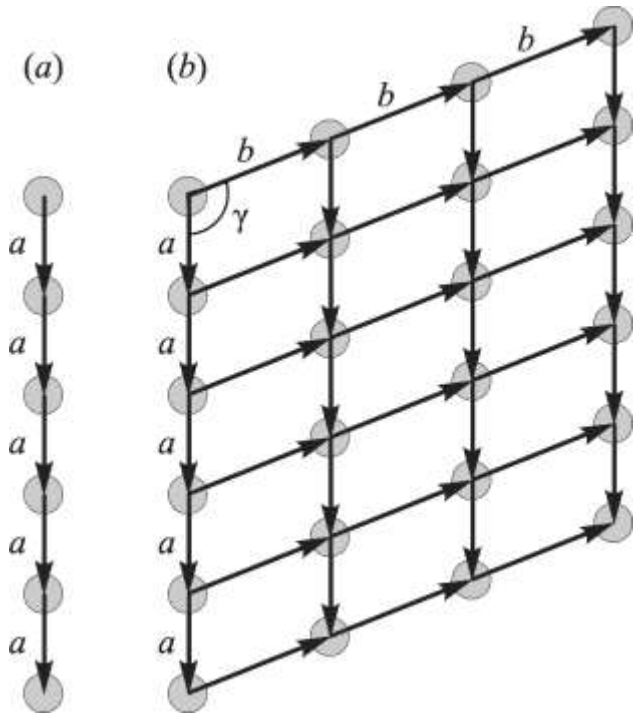

Figure 2.1
Simple translation to form a plane lattice.

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1. No matter how we repeat the lattice nodes, only five kind of plane lattices can be formed. These are:
   - Square
   - Rectange
   - Diamond
   - Hexagonal
   - Oblique or parallelogram

- All these lattices which have nodes only at the corners are called “primitive unit mesh”, except the diamond lattice which is a body centered lattice.

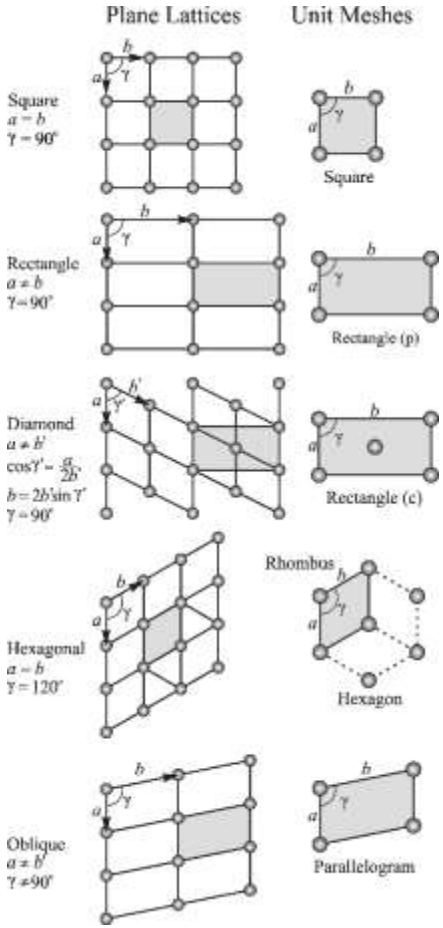

Figure 2.2 Plane lattices and unit meshes.

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We see patterns showing translational symmetry in everyday life

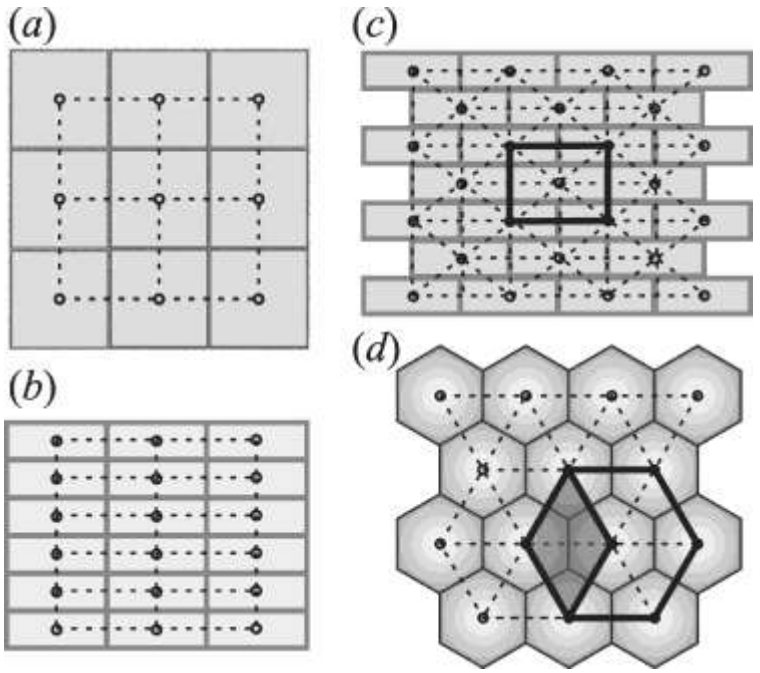

Figure 2.3
Plane lattices and unit meshes in everyday life.

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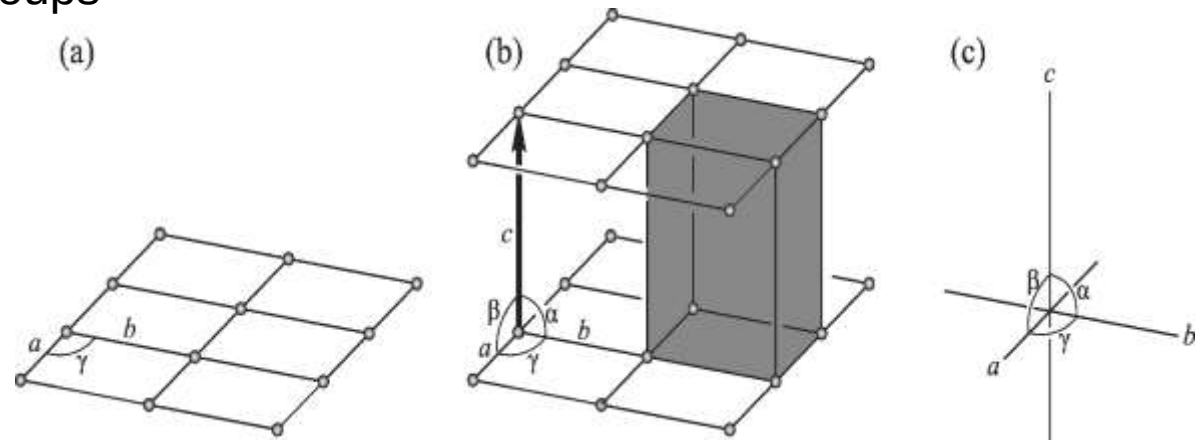
1. A Space lattice is formed by stacking plane lattices on top. The volume outlined by lattice nodes is called unit cell (like unit mesh but in 3 dimension)
2. The edges of the unit cell are parallel to the crystallographic axes and are denoted a,b, and c. The angles between the axes are α (between b and c) β (between a and c), and ɣ (between a and b)
3. The five plane lattices can make 14 possible different patterns of space lattice when repeated in the 3rd dimension. These 14 different space lattices are known as “Bravais Lattice” (pronounced Bra-Vay)
4. Depending on the shape of the unit cells, Bravais Lattice are divided into six groups



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1. These six unit cell shapes define the six crystal system
2. These are:
   a. Triclinic
   b. Monoclinic
   c. Orthorhombic
   d. Hexagonal
   e. Tetragonal
   f. Isometric
3. Except for Triclinic, each other system has more than one Bravais Lattice (primitive, body centered and face centered)
4. Triclinic lattice is produced by stacking an oblique plane lattice in a direction oblique (i.e., not at right angles) to a and b axis.

$$a \neq b \; ; \; \alpha \, , \, \beta, \, \gamma \neq 90°$$

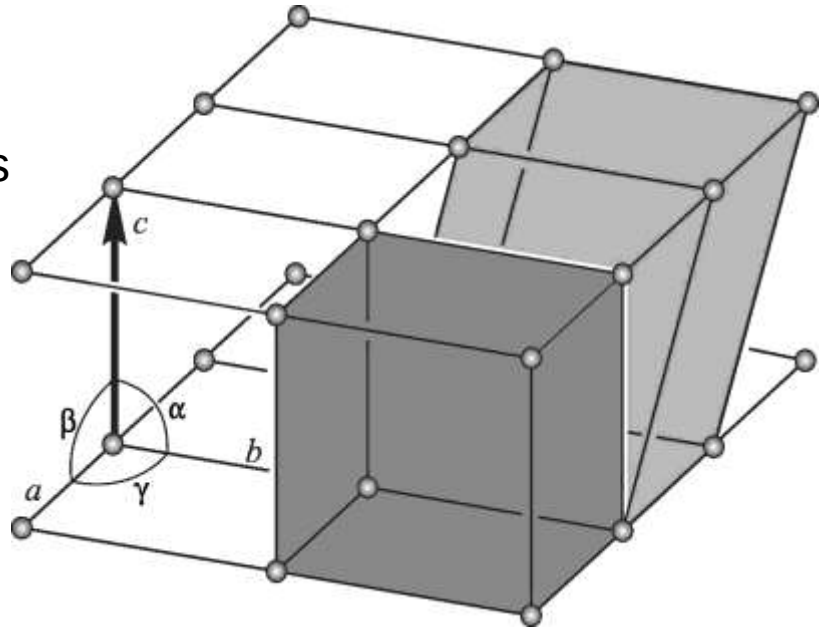

Figure 2.5 Triclinic Bravais lattice.

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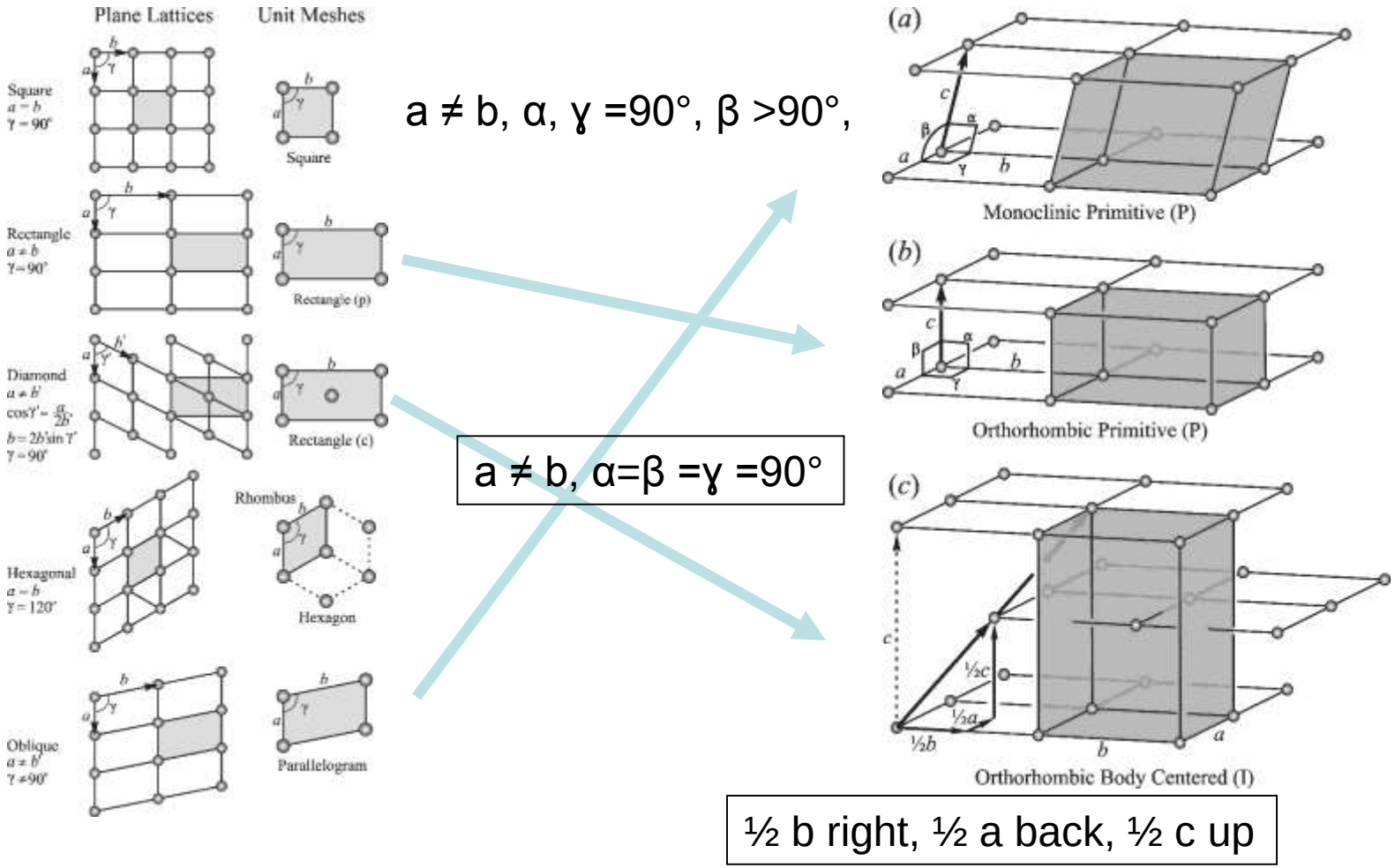

Figure 2.6 Bravais lattices produced by translation of rectangular plane lattice where *a* and *b* are different lengths and angle γ= 90°

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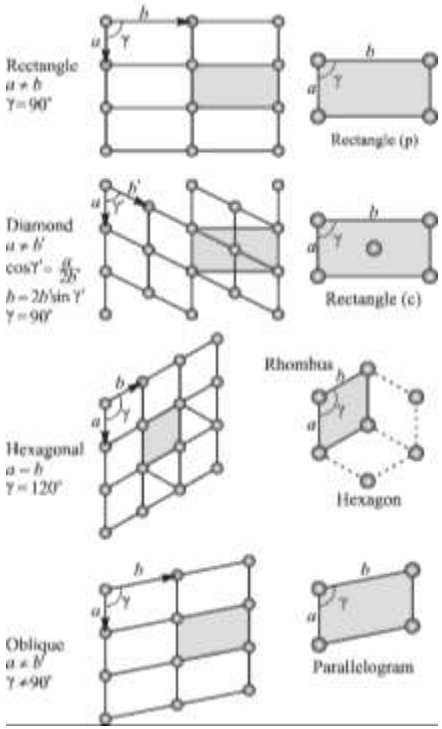

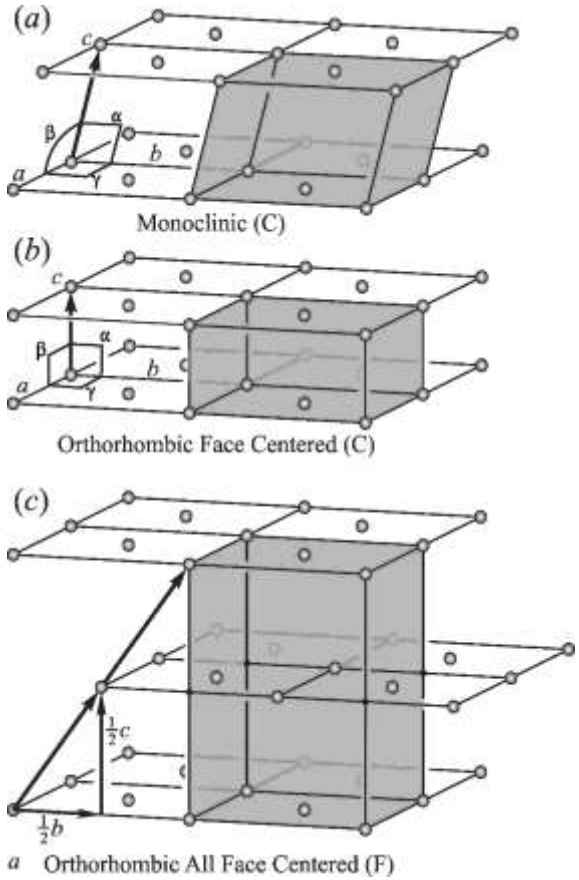

½ b right, ½ c up

Figure 2.7 Bravais lattices produced by translation of a centered rectangular plane lattice where *a* and *b* are different lengths and γ= 90°.

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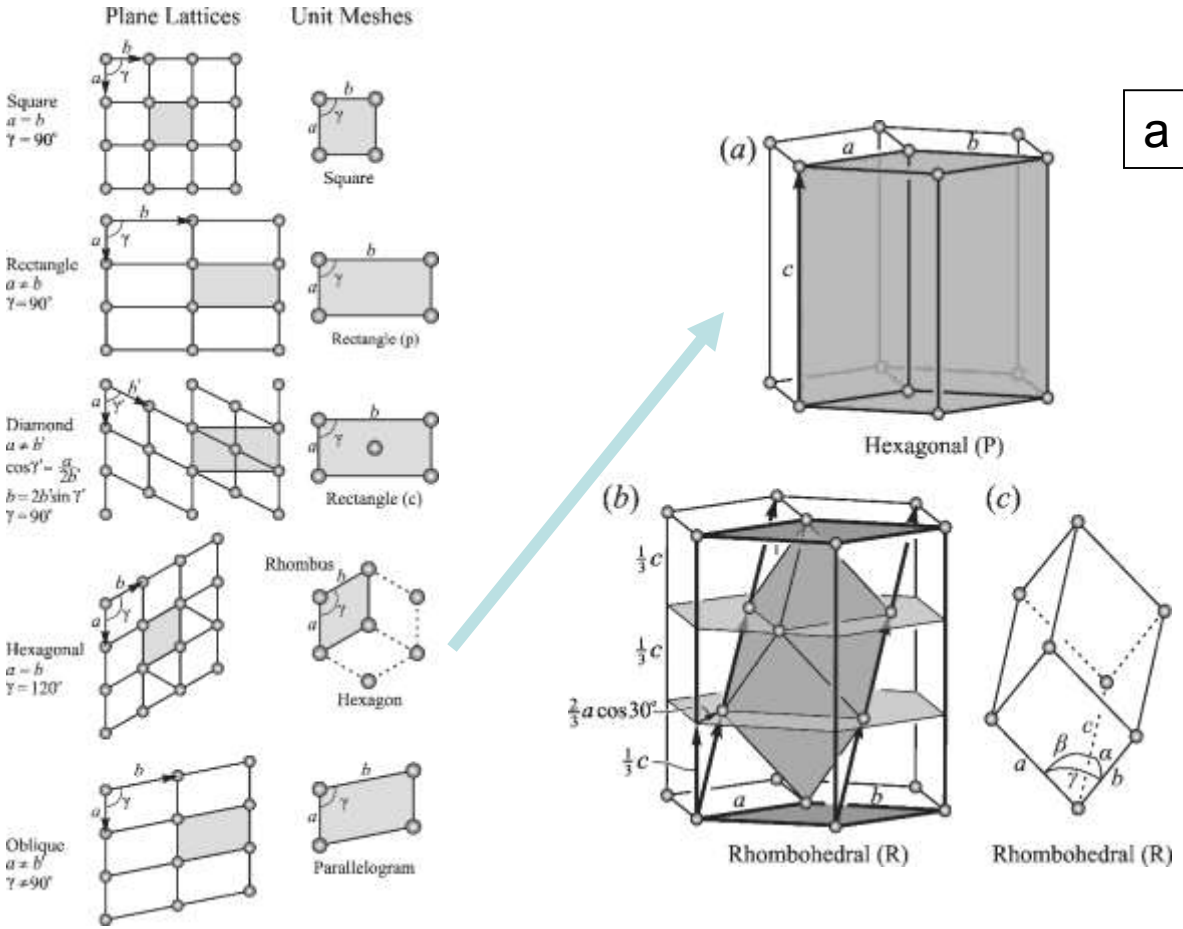

a = b ≠ c; α=β =90°, ɣ = 120°

Figure 2.8 Bravais lattices produced by translation of a hexagonal plane lattice.

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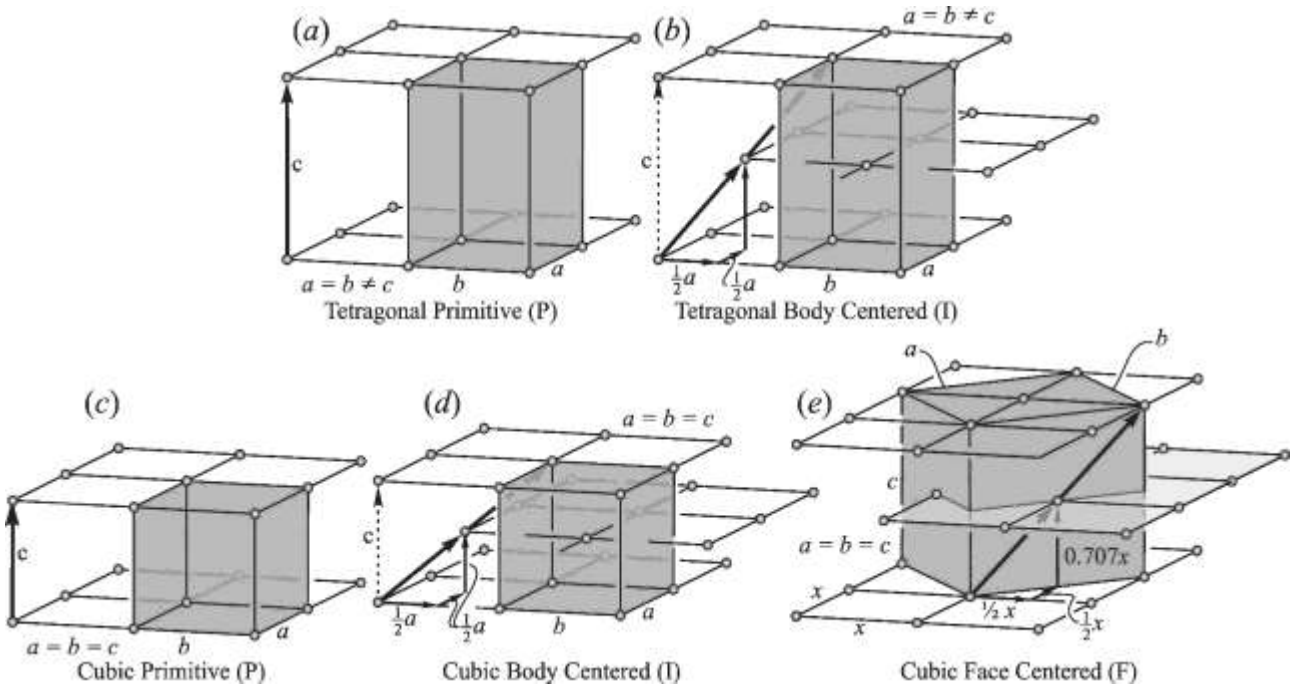
$a = b \neq c;\ \alpha=\beta = \gamma =90°$



$a = b = c;\ \alpha=\beta = \gamma =90°$

Figure 2.9 Bravais lattices produced by translation of a square plane lattice whose dimensions are *a* = *b*.

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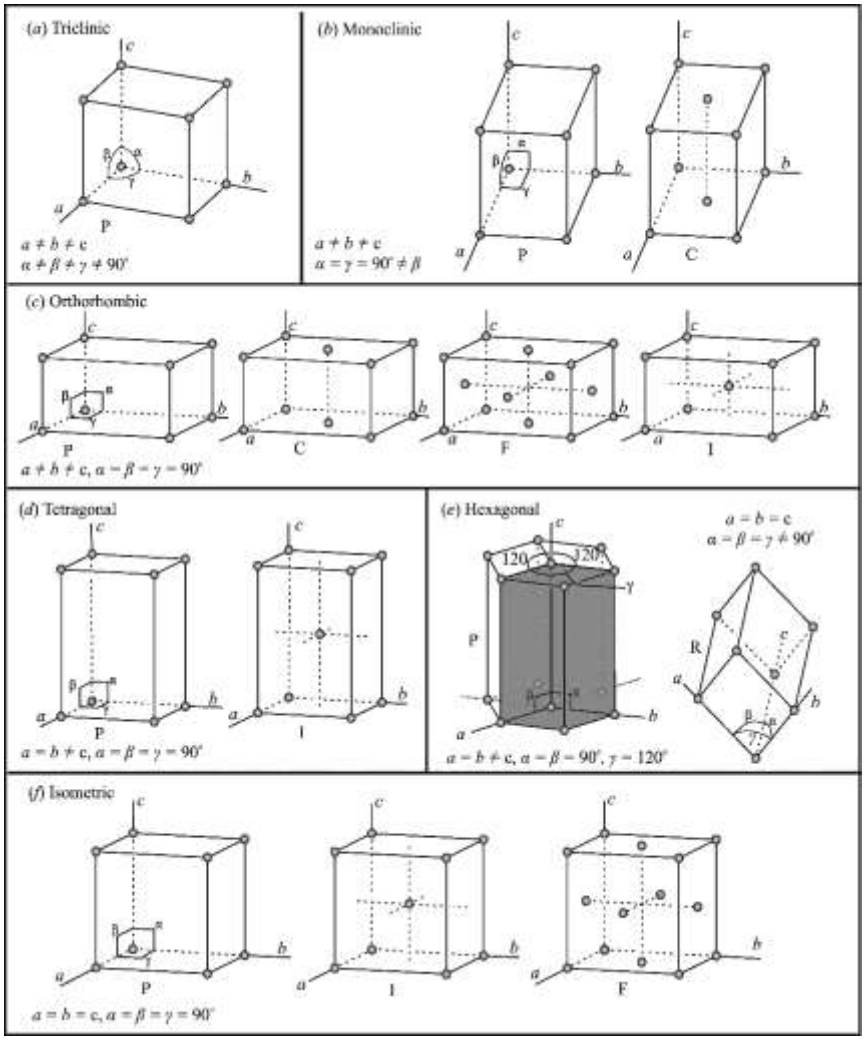

Figure 2.10 The 14 Bravais lattices define six different three-dimensional volumes (*a*–*f*) that correspond to the unit cells of the six crystal systems.

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