POROSITY

The porosity of a rock is the fraction of the volume of space between the solid particles of the rock to the total rock volume. The space includes all pores, cracks, vugs, inter- and intra-crystalline spaces. The porosity is conventionally given the symbol f, and is expressed either as a fraction varying between 0 and 1, or a percentage varying between 0% and 100%. Sometimes porosity is expressed in 'porosity units', which are the same as percent (i.e., 100 porosity units (pu) = 100%). However, the fractional form is ALWAYS used in calculations.

Porosity is calculated using the relationship

$$\phi = \frac{V_{pore}}{V_{bulk}} = \frac{V_{bulk} - V_{matrix}}{V_{bulk}} = \frac{V_{bulk} - \left(W_{dry} / \rho_{matrix}\right)}{V_{bulk}},$$

where: V_{pore} = pore volume
V_{bulk} = bulk rock volume
V_{matrix} = volume of solid particles composing the rock matrix
W_{dry} = total dry weight of the rock
ρ_{matrix} = mean density of the matrix minerals.

The initial (pre-diagenesis) porosity is affected by three major microstructural parameters. These are grain size, grain packing, particle shape, and the distribution of grain sizes. However, the initial porosity is rarely that found in real rocks, as these have subsequently been affected by secondary controls on porosity such as compaction and geochemical diagenetic processes. This section briefly reviews these controls.

Grain Packing

The theoretical porosities for various grain packing arrangements can be calculated. The theoretical maximum porosity for a cubic packed rock made of spherical grains of a uniform size is 0.4764, and is independent of grain size. The maximum porosity of other packing arrangements is shown in Table 2.1 and Figure 2.1.

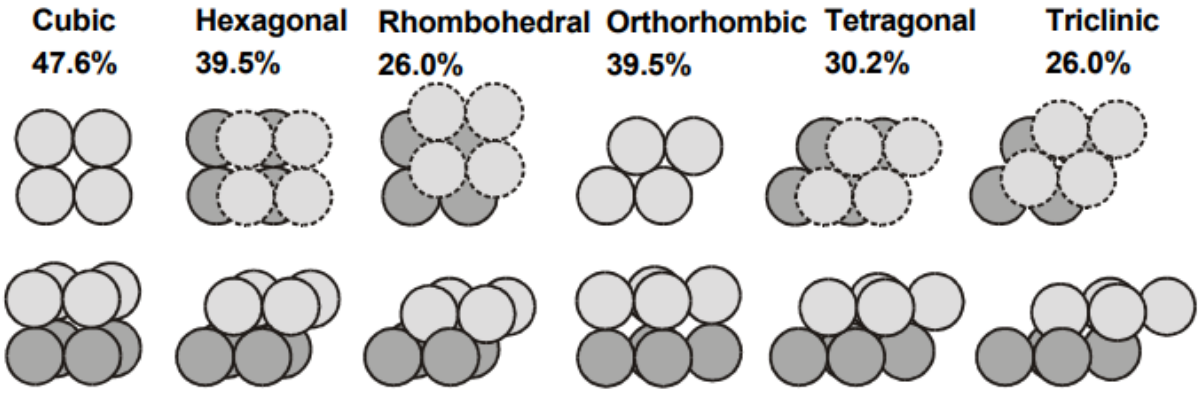

Figure 2.1 Ordered packing arrangements.

Table 2.1 Maximum porosity for different packing arrangements

Packing	**Maximum Porosity (fractional)**
Random	≥0.399 (dependent on grain size)
Cubic	0.476
Hexagonal	0.395
Orthorhombic	0.395
Rhombohedral	0.260
Tetragonal	0.302
Triclinic	0.260