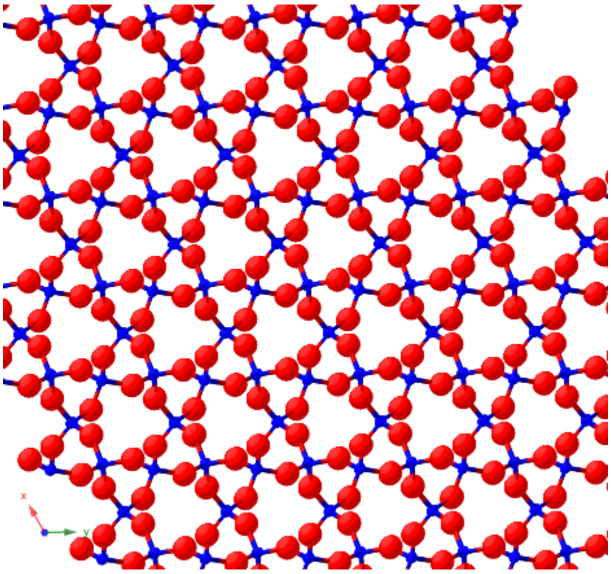
What is the origin of macroscopic crystal faces

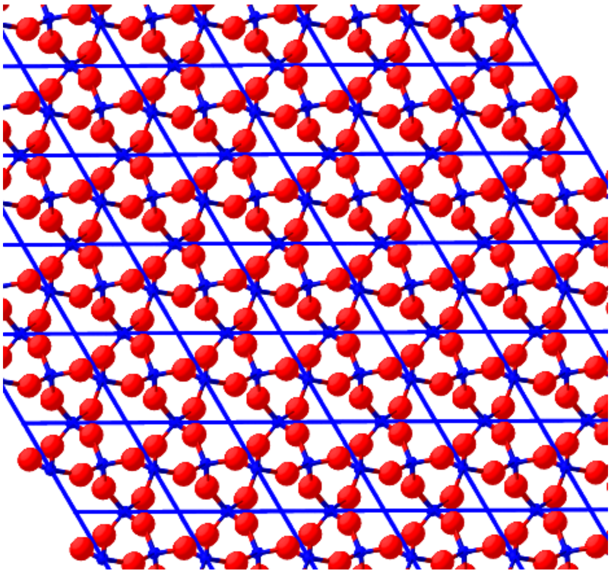
Well-formed macroscopic crystals usually exhibit faces, which are nearly perfect planes. Quartz crystals are such an example.

We know that these faces are macroscopic expressions of the periodic distribution of atoms in the crystal. On the atomic level, we could see the following picture by looking along the hexagonal prism.



Here the red atoms represent oxygens whereas the blue atoms are silicon atoms. The links between the red and blue atoms indicate the existence of chemical bonds.

Looking at this we can see that the atoms are placed regularly and we observe some repeating patterns in this structure. We can draw the following lines and see what are their properties.

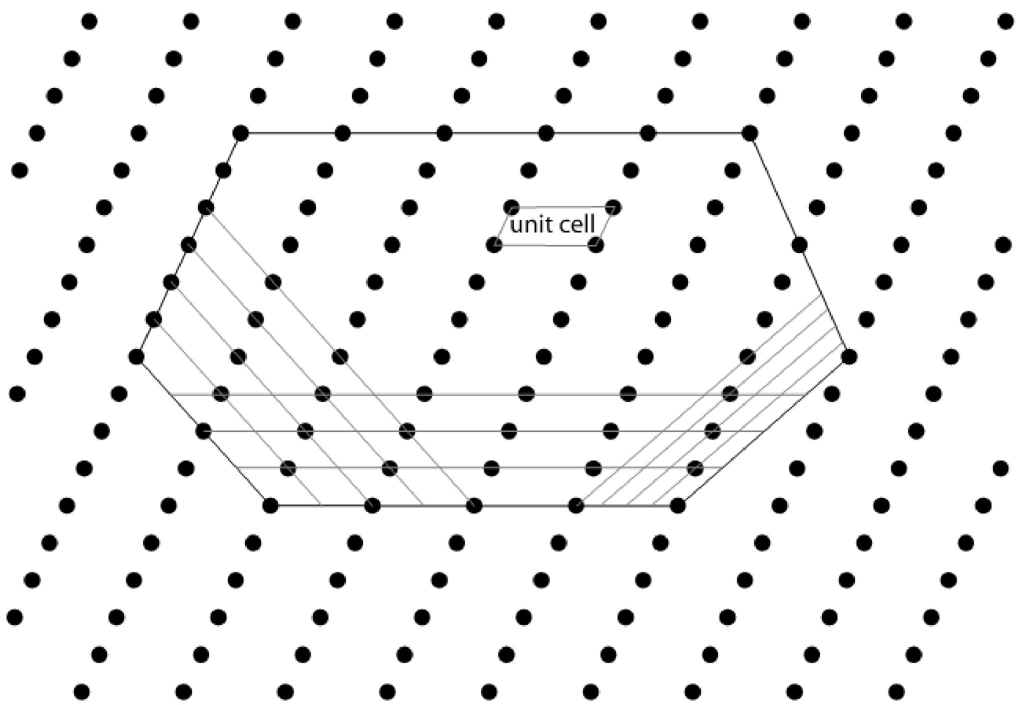


We observe first that the series of parallel lines are all equidistant and form identical parallelograms or rhombi in this case. Another interesting property is that the content of each parallelogram is identical. From this figure, we conclude that a crystal of quartz consists of a repeating pattern that covers the surface without any voids.

In other words the parallelograms and their contents form periodically repeating patterns that fully cover the plane,. In crystallography, the parallelogram is called a **unit cell**. This property is not only valid for quartz crystals but all possible crystals of any combination of chemical elements.

To complete our description of crystal structures, we shall extend our concept of a unit cell to three dimensions. In this case, the unit cell is a parallelepiped, which is delimited by three pairs of parallel planes.

Based on the repeating pattern of unit cell contents, we can understand the origin of the crystalline faces. In the following two-dimensional example, the periodicity of the structure is only characterized by the nodes of the unit cells. In other words, these nodes strictly characterise the lattice periodicity and are not atoms.



In two-dimensional crystals, the faces are represented by lines that delimit the crystal. In three dimensions, the faces delimit the crystal. We call them lattice planes because three lattice points determine them.