X-Ray Diffraction and X-Ray Crystallography

Diffraction
- The complex patterns of a diffracted wave result from interference between different rays that traveled to the observer along different paths.

Diffraction
- Diffraction effects are most noticeable when the wavelength of waves is similar to the size of the diffracting objects or apertures.
Diffraction of Visible Light

- Visible light is diffracted by slits/objects that are spaced at ~ 500 nm (0.5µm)

X-Rays and Crystals

- Wavelengths of x-rays are around 10 to 0.01 nanometers, approximately one thousand times shorter than the wavelength of visible light.

- X-rays should be diffracted by slits/objects ~ 0.1 nm (1 Angstrom)

X-Rays and Crystals

- Spacing of atoms in a crystal lattice are in the order of 0.1 nm

- X-rays have wavelengths in the order of 0.1 nm

- X-rays are diffracted by crystals
In 1919 A.W. Hull noted the following:

- Every crystalline substance can produce an x-ray diffraction pattern;
- The same substance always gives the same pattern;
- A mixture of substances each produces its pattern independently of the others.

The diffraction pattern of a pure substance is like a fingerprint of the substance.

Minerals can be identified by their diffraction pattern.

Bragg’s Law

\[ n\lambda = 2d \sin \theta \]

http://www-outreach.phy.cam.ac.uk/camphyl/xraydiffraction/xraydiffraction_exp.htm

Multiple d-Spacings
X-Ray Diffractometer

XRD Patterns

Quartz

Calcite

X-Ray Diffractometer

XRD Patterns

greenstone  RAVL 1

Anorthite  4.06 %
Augite  3.14 %
Albite  24.15 %
Hornblende  15.58 %
Epidote  22.00 %
Chlorite  15.07 %
Quartz  12.40 %
XRD and Clays

Serpentine, var. Antigorite

Serpentine, var. Lizardite