Polymorph Encyclopedia Article

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Polymorph

A polymorph is a chemical composition that can crystallize into more than one type of structure. This results in different **minerals** with identical compositions and distinguished by their crystallography.

Some common examples of polymorphs are calcite and aragonite. The composition of these two minerals is $CaCO_3$, but calcite is rhombohedral while aragonite is orthorhombic. **Diamond** and **graphite**, both of which are pure **carbon**, are also polymorphs. Diamond, however, is cubic while graphite is hexagonal. Pyrite is the cubic form of FeS_2, marcasite, the orthorhombic version.

A single chemical composition that can form polymorphs does so as a response to varying conditions of formation. The **temperature**, pressure, and chemical environment all affect the crystallization process and can determine the resulting polymorph. For example, diamond requires very high pressure to crystallize, while graphite forms at lower pressures. For the composition $CaCO_3$, calcite is the high temperature-low pressure polymorph while aragonite forms at higher pressures and lower temperatures.

Many polymorphs are only stable within a certain range of conditions and solid-state transitions from one polymorph to another are possible. When low-quartz, which is rhombohedral, is heated to above 1063°F (573°C), it instantaneously goes through an internal structural displacement, or shift, to form hexagonal high-quartz. This type of polymorphic transition is reversible if the temperature is lowered. Other polymorphic transitions involve extensive internal rearrangement and reconstruction of the crystal and subsequently require significantly more energy. The examples of diamond-graphite, pyrite-marcasite, and calcite-aragonite are all known as reconstructive transitions. The large amounts of energy required to effect these polymorphic changes makes the resulting mineral more stable and the process less reversible than with a displacive transition.

See Also

Crystals and Crystallography; Mineralogy