Part I: Nucleation and Crystal Growth

The ever increasing amount of data on crystal arrangement in igneous and metamorphic rocks, alloys and ceramics, shows that the microtextures of these materials result from sequences of crystal growth and resorption. Metallurgists have become knowledgeable in the interpretation of textures and can make or modify textures of alloys in order to obtain specific responses to traction, distortion, etc. The modifications in texture can be reproduced or changed as often as desired. By analogy, it is probable that the microtextures observed in rocks may result from the same processes that govern similar textures in manufactured products.

The comparative approach has limitations as geological materials are often rich in silicates so that, in rocks, minerals generally have quite different shapes and habits to those of alloys or ceramic materials

The chemistry of geological samples is often very complex and may have a dozen or more principal constituents. Thus the kinematics of mineral reactions in rocks may differ from those that happen inside and at the exits of blast furnaces and ceramic kilns. Whilst the history of artificial products is rather simple and short, the same cannot be said of the history of rocks. Indeed, whether these are metamorphic or igneous in origin, the simple fact that they were found at the surface of the earth implies that they have been transported mechanically out of their original petrogenetic environment.

Texture represents the quest for an equilibrium state between the various mineralogical phases of a rock. A texture that has been inherited from an earlier 'deep-seated' stage may be recognisable in subsequent mineral rearrangements formed by responses to the thermodynamic conditions of the surface.

One might expect that the older the rock, the stronger and more apparent its textural rearrangement will be and the more fully accomplished its new equilibrium. Actually, this does not seem to be true as some very old igneous and metamorphic rocks (older thant 3.5 billion years) exhibit mineral arrangements and microtextures identical to those observed in very young rocks of the same sort. The idea that original microtextures are erased by time is thus difficult to support and quite conjectural. Erasing intensity should be directly proportional to the energy levels crossed by the rock during its ascent to the surface since these allow for jumps over the potential barriers which controlled the stability or metastability of the original phases and microtextures. Thus the longer and more complicated the thermal, tectono-thermal or tectonic history of an igneous or metamorphic rock, the more pronounced will be its dual texture. Under surface conditions textural arrangements will be either discrete or at least limited, except at the interfaces of the atmosphere-hydrosphere-biosphere and lithosphere. Microtextures of such rocks will thus appear as either:

- mineral architectures essentially of primary origin established in the crust or upper mantle, or as,
- more complex and secondary architectures in which traces of previous textures can be found.

Before describing the principal textures of igneous and metamorphic rocks and investigating their histories it is useful to review the fundamental mechanisms that govern the making and unmaking of mineral microtextures. Some of these textures can be considered on theoretical thermodynamic principles. Other rely on data obtained from experimental work in metallurgy, glass and ceramics, plastic and concrete studies, and on data provided by experimental petrology at high temperatures and pressures that have been conducted in the last few years.

Chapter 1

Nucleation Theories

By analogy with metallurgy or chemistry, it can be assumed that the appearance of the first 'cells' of a given phase within an evolving system is triggered by two slightly different mechanisms, namely 'homogeneous' and 'heterogeneous' nucleations.