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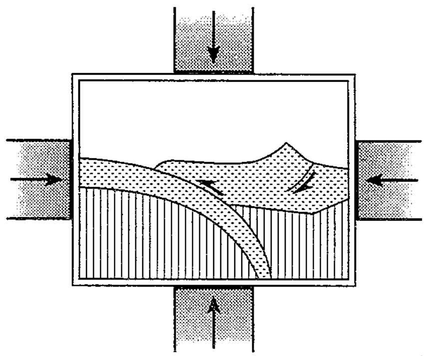
Deformation Mechanisms
Rheology
Microstructures



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Microstructure Development in Naturally Deformed Carrara marble (Alpi Apuane, Italy)

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The Alpi Apuane region represents a former crustal-scale shear zone developed at mid-crustal levels (greenschist facies) during the Tertiary evolution of the northern Apennine thrust system (D1), later involved in exhumation and extensional collapse (D2).

The presence of marble in different geometrical positions, the partitioning of strain, the development of different generations of structures formed during thermal perturbation provided the preservations of various calcite microstructures that allowed to unravel the thermomechanical evolution of this portion of the northern Apennine during continental collision and exhumation.

The microstructural features and calcite/dolomite thermometry of two main groups of microstructures will be discussed:

a) the static microstructures, characterized by the typical granoblastic polygonal "foam" grain shape and by an increase in grain size from approximately 0.08-0.1 mm to 0.15-0.3 mm from the eastern to the western part of the Alpi Apuane metamorphic complex. Calcite/dolomite investigations yield increasing temperatures from 360-390°C in the east to 430-440°C in the west suggesting a direct control of the temperature on the grain size;

b) the dynamic microstructures, characterized by shape and crystallographic preferred orientations, mechanical twinning and dynamic recrystallization features. These microstructures can be found in different tectonic settings: i) associated with decametre-thick late-D1 shear zones in the eastern part of the Alpi Apuane; ii) within millimetre- to decimetre-thick D2 shear zones in the western part.

Microstructures associated with the decametre-thick shear zones show a coarse grain size (0.1-0.2 mm) and calcite/dolomite temperature of 380-390°C, while the microstructures in the millimetre- to decimetre-thick D2 shear zones show grain size reduction (0.02-0.05 mm) associated with lower temperatures (about 350°C).

Though commonly considered homogeneous and statically recrystallized, the Alpi Apuane marbles reveal complex relationships between fabric development, deformation mechanisms and thermal evolution.