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Neogene Tectonic Evolution of the Mont Blanc Area

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The Mont Blanc massif (MB) in the western central Alps forms part of the chain of External Crystalline Massifs belonging to the Helvetic paleogeographic domain. Morphological features (pronounced topography, steep slopes) and many previous thermochronology studies indicate a fast and young (late Neogene) exhumation. This study examines the overall tectonic evolution of the Mont Blanc area, with the main focus on young structures possibly related to exhumation processes. The study area is situated all around the Mont Blanc massif and places particular emphasis on the Helvetic cover units and the three main tectonic structures framing the Mont Blanc basement massif: (1) the Chamonix line, (2) the Mont Blanc back-thrust/-fold, and (3) the Pennine Frontal Thrust. The Alpine deformation of the area is dominated by NW-directed shear developing the Helvetic fold-and-thrust belt, with MB forming the crystalline core of the lowermost Morcles nappe. Shear concentrates in the overturned limb (Chamonix shear zone) and on the contact between autochthonous and allochthonous Helvetic units in the upright limb (equivalent to the Diablerets thrust). The autochthonous cover units in the upright limb are basically undeformed, whereas all higher units are strongly sheared and develop a distinctive spaced crenulation cleavage associated with a well-developed mineral lineation. After the formation of the large-scale Morcles fold-nappe, the basement core formed a rigid obstacle to subsequent deformation and therefore governed the deformation of subsequent structures. This led to a regional variation in stretching directions associated with the same overall deformation event. Especially the SE parts of the study area show a significant strike-slip component during ductile shear, whereas in the northern parts the structures indicate purely thrust related movements. This is due to the position and reniform shape of the massif, causing the overthrusting cover units to follow its predefined outline. Dextral transcurrent movements are also expressed as mylonitic shear zones often found in the Mont Chétif basement slice in the Courmayeur area.
The post-nappe-formation history shows widely distributed brittle dextral transpressive movements on both the internal and external sides of the massif. On the SE side, abundant NNE-SSW trending dextral faults imply a local NE-SW-directed compressional stress field, with this shortening impinging on the Mont Blanc massif, corresponding to a restraining bend scenario in the Rhône-Simplon fault system. We postulate that the area of Courmayeur is an area of strain concentration, induced by the geometry and position of the basement massif relative to the continuation of the Rhône-Simplon fault system. However, since there is no structural evidence for young exhumation, we suggest that the most recent uplift of MB relative to its surroundings is more widely distributed and not restricted to discrete structures bounding the massif itself.