The Swiss Alps: from subduction to collision and exhumation

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Recent geophysical investigations have highlighted the crustal structure of the Swiss Alps: a bivergent orogen, in which upper crustal units were stacked northwards and southwards above an asymmetric subduction geometry involving lithospheric mantle and lower continental crust. Based on the type of material entering the S-dipping subduction zone and the evolving subduction geometry, three phases can be distinguished:

1. Subduction of oceanic crust (Cretaceous)
2. Underplating of continental fragments (Paleogene)
3. Collision phase (Neogene), which involved episodes of incipient collision of continental crust, underplating of continental crust, exhumation of the Penninic block with back-thrusting and erosion, and an episode of shunting/"indentation" with bivergent thrusting propagating out into the N and S forelands of the Alps.

Numerical dynamic modeling explains how upper crustal material from thinned crustal sections can be subducted to greater depths, whereas in normal crustal sections the upper crust detaches from the lower crust and becomes accreted to the upper plate. The entrance of the European margin into the Alpine subduction zone triggered back-thrusting along the Insubric Line and the adjacent units ultimately leading to the development of a bivergent thrust belt. Underplating and associated N-directed thrusting (pro-shear) produced the Penninic and Helvetic nappe stack, while S-directed thrusting (retro-shear) resulted in the Southalpine nappe pile. Underplating and plug-uplift between pro- and retro-shear accompanied by erosion led to the exhumation of high-grade rocks in the core of the orogen.