well as the detachment zone. These features are consistent with the N-S extensional regime still prevailing in the Southern Aegean region.

Salemink, J., 1985: Skarn and ore formation at Seriphos, Greece, as a consequence of granodiorite intrusion. PhD Thesis, University of Utrecht.

Alpine structures and their evolution: numerical modeling and natural examples

O.A. Pfiffner

Institute of Geological Sciences, University of Bern, Switzerland

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. 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.

A simple conceptual model for modes of accretion, erosion and subduction at convergent margins can be described in terms of the mass flux among four components: the accretionary wedge (pro-wedge); plug uplift; retro-wedge; and the subduction zone, the latter consisting of a conduit of slowly-deforming material and a rapidly-deformed subduction channel. The subduction conduit widens or narrows in response to flexural loading of the downgoing plate and the relative fluxes of tectonic erosion, accretion and underplating. Crustal-scale models span a continuum of behaviour from single-vergence, with development of a landward dipping (pro-)shear zone, to double-vergence with formation of a seaward dipping (retro-)shear zone. Results show that single-vergent deformation occurs whenever the mass flux lost by subduction is equal to or greater than incoming mass flux. This mode can develop dynamically by flexural compensation and/or subduction retreat.

The combined action of pro-shear (nappe stacking) and retro-shear (back-thrusting) uplifts a plug between the two shear zones. Subsequent focusing of shear along the retro-shear zone results in rotation of the plug and overlying units, leading to crustal-scale backfolds. Heterogeneities in the pro-crust focus shear and lead to the development of "nappe structures". Accretion of small continental terranes within a model subduction zone can cause crustal-scale fold nappes and shear zones to develop, with accompanying tectonic underplating and/or frontal accretion. In the case of the Swiss Alps, 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 plug-uplift between pro- and retro-shear accompanied by erosion led to the exhumation of high-grade rocks in the core of the orogen. The model experiments predict features relevant to Alpine dynamics, including (1) similar crustal thicknesses and exhumation patterns, (2) continued accretion and subduction of upper crustal fragments allowing high-pressure metamorphic conditions, (3) tilting and exhumation of lower crust when a midcrustal weak zone is present, and (4) "shunting" of material across the strong lower crustal wedge of the upper plate.

Experiments concentrating on nappe-scale structures suggest that the formation of detachment folds require a high thickness ratio between detachment horizon and the competent unit above. Imbricate thrust sheets evolve in the case where the detachment horizon is thin. Lateral heterogeneities in the cover sediments control the nappe internal structures. For example, discontinuities such as present in passive margin sequences are preferential sites for the nucleation of folds and thrust faults.

Morphogenesis: interaction between crustal and surface processes

O.A. Pfiffner

Institute of Geological Sciences, University of Bern, Switzerland

Morphogenesis at convergent plate boundaries reflects material fluxes at the surface and in subsurface. The fate of material entering a convergent margin is many-sided. In the simplest cases it gets subducted into the mantle, or accreted to the margin. Accretion leads to the formation of an orogenic wedge, the growth of which implies internal deformation and the creation of an elevated area (surface uplift), which in turn triggers denudation. Thus,