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Evidence for two-phase plane strain deformation in the central Oman Mountains: Chocolate tablet structures in Wadi Ad Dil, Hawasina Window

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The main deformation phase of northern Oman is the obduction of allochthonous Hawasina Basin-derived sedimentary rocks and the Semail Ophiolite during the Late Cretaceous. The allochthonous thrust onto the passive Arabian platform. Obduction was followed by uplift (doming) and the development of the central Oman Mountains with the Hawasina Window in its core.
We focus, for the first time, on chocolate tablet structures in the sedimentary rocks of the Al Jil Formation (Hamrat Duru Group, Hawasina unit). The Al Jil Formation is characterized by an alternation of sandstone, limestone, dolostone, calcarenite, and chert layers, competence contrast between various lithologies and variable thicknesses (cm to dm) of layers. Contractional deformation of these package of rocks led to boudinage in more competent lithologies with blocky and pinch-and-swell geometry at the same time, asymmetric boudins, mullions and chocolate tablet structures. The chocolate tablet boudins are restricted to steeply dipping limbs of tight to isoclinal folds (F1) with a gently plunging fold axis towards the SSE and a steeply dipping fold axial plane towards WSW. Layer-parallel extension took place in two directions which are sub-perpendicular to each other, resulting into two sets of calcite-filled boudin necks at mutually high angle. One set of veins is parallel, while the other set is sub-vertical to the axes of the related folds. Furthermore, the sets of boudin necks are longitudinal and orthogonal to the bedding. Asymmetrical folds (short and long limb) have an amplitude up to several km and preserve parasitic folds with an amplitude up to hundreds of meters.
We assume that the chocolate tablet boudinage linked with the isoclinal folding is related to the D1 folding during obduction in the Late Cretaceous. According to the theory of Ghosh (1988) and observations by Marques et al. (2012), the principle strain axes rotate in a flattening type of bulk deformation leading to steeply dipping boudins (hinge parallel extension) followed by sub-horizontal boudins (hinge perpendicular extension). The direction of compression ($\sigma 1$) remains constant during the folding.
The boudinaged layers are folded (F2) whereby the D2 fold axes are plunging gently towards the SE and the planes of these folds are gentle dipping towards the SSW. Observed stretching lineation on the limb of F1 and F2 folds indicates flexural-slip which leads to bigger inflexion and supported the buckling.

Ghosh, S.K. (1988): Theory of chocolate tablet boudinage. Journal of Structural Geology, 10(6), 541-553.
Marques, F.O., Fonesca, P.D., Lechmann, S., Burg, J.-P., Marques, A.S., Andrade, A.J.M. and Alves, C. (2012): Boudinage in nature and experiment. Tectonophysics, 526-529, 88-96.