Geophysical Research Abstracts, Vol. 7, 04507, 2005
SRef-ID: 1607-7962/gra/EGU05-A-04507

Soft sediment deformation with anisotropic volume loss

M. Hölzel, M. Ebner, B. Grasemann, M. Wagreich

Department of Geological Sciences, University of Vienna, Austria

(monika.hoelzel@univie.ac.at / Fax: +43-1-4277/9534 / Phone: +43-1-4277/534 35)

Numerous soft sediment structures occur in the Ingering Formation (Lower/Middle Badenian, ∼2000 m), which is part of the Neogene basin fill of the Fohnsdorf basin (Austria). Sediments have been interpreted as prodelta to delta front deposits (Sachsenhofer et al. 2000a; Strauss et al. 2001; Hölzel and Wagreich 2004), with a southward prograding trend. Subaqueous debris-flow (mollusc breccia with angular rock fragment) and clay strata contain boudins, pinch-and-swell structures, ptygmatic folds, rotated top-to-S reverse faults and rotated clasts, developed under different stress conditions within the same layers.

Using a finite element model, Hölzel et al. (submitted) have modelled the rotational behaviour trapezoidal shaped mylonite clast, which resembles a δ-clast ......(cf. Passchier and Trouw 1996), although it is genetically unrelated. The geometry suggests a north- to northwest-directed shear sense, but, sedimentological, structural and palaeogeographical criteria indicate S- to SE-directed sediment slumping. The most important result of this study is that the rotational behaviour of the clast is controlled by the kinematic vorticity number W_k, which is a measure of the pure ($W_k = 0$) and simple shear ($W_k = 1$) component of flow. The finite element model of the investigated soft sediment deformation structure suggests a highly pure shear dominated flow ($W_k < 0.5$).

However, the model suggests that the initial thickness of the sediments was reduced by more than 30 %. If this value is compared to estimates of sediment compaction due to porosity reduction for shales at burial depths >1000 m (e.g. Baldwin and Butler 1985), the modelled stretching component parallel to the layering required by the isochoric flow is clearly an overestimation (1000 m is the estimated minimum value of the sedimentary cover of the investigated beds during the end of sedimentation of the Ingering Formation (Sachsenhofer et al. 2000a).

In order to address the problem of anisotropic volume loss we developed a continuum mechanic model using following boundary conditions based on sedimentological data: (i) 20 % volume loss and (ii) an estimated stretch of 14 % parallel to the bedding. Including a geologically reasonable range of W_k suggested by the finite element model, all components of a plain strain deformation tensor can be calculated. Plotting W_k against the effective shear strain component shows that the relationship is almost linear in this section ($W_k < 0.5$) with an only slight positive slope. Therefore we conclude that finite soft sediment deformation, which is controlled by volume loss and a dominant pure shear component, is nearly insensitive to any shearing of the sediment body.

References

Baldwin, B., and Butler, C.O., 1985, Compaction Curves: Bulletin of the American Association of Petroleum Geologists, v. 69, p. 622-626.

Hölzel, M., Grasemann, B., and Wagreich, M. submitted, Numerical modelling of clast rotation during soft-sediment deformation: a case study in Miocene delta deposits: Journal of Sedimentary Research.

Hölzel, M., and Wagreich, M., 2004, Sedimentology of a Miocene delta complex: the type section of the Ingering Formation (Fohnsdorf Basin, Austria): Austrian Journal of Earth Sciences, v. 95/96, p. 80-86.

Passchier, C.W., and Trouw, R.A.J., 1996, Microtectonics: Berlin, Springer, 283 p.

Sachsenhofer, R.F., Strauss, P., Wagreich, M., Abart, R., Decker, K., Goldbrunner, J.E., Gruber, W., Kriegl, C., and Spötl, C., 2000a, Das miozäne Fohnsdorfer Becken - Eine Übersicht: Mitteilungen der. Gesellschaft der Geologie- und Bergbaustudenten Österreichs, v. 44, p. 173-190.

Strauss, P., Wagreich, M., Decker, K., and Sachsenhofer, R.F., 2001, Tectonics and sedimentation in the Fohnsdorf-Seckau basin (Miocene-Austria): from a pull-apart basin to a half-graben: International Journal of Earth Sciences, v. 90, p. 549-559.