Geophysical Research Abstracts
Vol. 15, EGU2013-2883, 2013
EGU General Assembly 2013

Forward and reverse modelling of salt diapirs formed by down-building

Naiara Fernandez and Boris J.P. Kaus

Geophysics and Geodynamics. Institute of Geosciences. Johannes Gutenberg University Mainz. J.-J.-Becher-Weg 21, D-55128 Mainz, Germany (fernande@uni-mainz.de)

Two end member processes are usually described to explain how salt diapirs form: (1) buoyancy instability (i.e. Rayleigh-Taylor instability) in which the density difference between salt and overburden induces upward motion of salt and (2) a down-building or syndepositional process in which salt structures grow while sediments are being deposited. Both processes have been extensively studied using forward numerical models, but few numerical models focus on the mechanical retrodeformation (reverse modelling) of salt diapirs, regardless their origin. Kaus and Podladchikov (2001) successfully performed mechanical retrodeformation of diapirs that developed as a result of buoyancy instability. Here, we focus on a time-reversal approach to retrodeform diapirs that are formed by down-building.

We have used the two-dimensional visco-elasto-plastic finite element code MILAMIN_VEP to perform both forward and synthetic backward simulations. Down-building process was mimicked using a fast-erosion condition at the surface, which keeps it flat and redistributes material at every time step. Initially, the interface between the salt and the overburden is perturbed using a sinusoidal geometry: a thin layer of sediments is present over a sinusoidal shaped salt layer so that the salt is closest to the surface at the domain centre. Several forward simulations are performed, using different initial parameters (rheological parameters, sedimentation rate and the geometry of the initial perturbation). Simulations are run until the salt layer is exhausted, which results in realistic salt dome structures.

Using the reversed time step method we have shown that the modelled salt structures formed by down-building can be retrodeformed to a geometry close to the initial one if the correct rheological parameters and sedimentation history through time are used. Once the method has been tested for a wider range of initial geometries and parameters, it will be used to retrodeform geometric reconstructions of natural salt structures (of unknown rheological properties). Mechanical retrodeformation of natural salt structures could be used, on the one hand, to better constrain the rheology of the salt and the involved brittle cover, and on the other hand, to validate available geometric interpretations. It can also be extended to three-dimensional situations provided that sufficient information is available on the regional sedimentation history. As such this is thus a promising new method that goes well beyond what standard kinematic restoration techniques can do.

Acknowledgements

Funding was provided by the European Research Council under the European Community's Seventh Framework program (FP7/2007-2013) ERC Grant agreement #258830.

References

Kaus, B.J.P. and Podladchikov, Y.Y., 2001, Forward and Reverse Modeling of the Three-Dimensional Viscous Rayleigh-Taylor Instability. Geophysical Research Letters, Vol. 28, NO. 6, Pages 11095-098