Geophysical Research Abstracts, Vol. 7, 07824, 2005
SRef-ID: 1607-7962/gra/EGU05-A-07824
© European Geosciences Union 2005

Stress field variations around overlapping faults with multiple slip events: a case study from the Pannonian rift system (Hungary)

L. Fodor

Geological Institute of Hungary, Budapest, Hungary (fodor@mafi.hu / 36-1-2510999)

The Pannonian basin of central Europe was formed by lithospheric stretching during the late early to late Miocene (∼18-6Ma) (Horváth and Royden, 1981). The initial rifting phase induced the formation of tilted blocks and half grabens of km to tens of km size (Tari et al. 1992). This so-called "syn-rift phase" superimposed a late Oligocene to early Miocene phase characterised mainly by strike-slip faulting. On the other hand, the syn-rift phase was followed a late middle to late Miocene "post-rift phase, during which faulting decreased but not terminated.

This three-phase evolution can be followed in some open-pit mines in the central Pannonian basin (Vértes Hills). Although the size of structures is not enormous, exposures in the mining area offered excellent preservation of minuscule details of all brittle structures.

The fault pattern of the area is characterised by curved, overstepping fault strands, which were probably interacting during deformation (Almási and Fodor 1995). The overlapping segments are 10 to 500m long, while the oversteps (relay ramps) are 0,2 to 20m wide. In most cases the overlapping fault segments are hard-linked with a short fault, a feature characteristic for more evolved state of fault evolution (Peacock and Sanderson, 1994). These connecting splays have directions moderately to highly oblique to the main fault segments.

Most fault planes bear nicely preserved slickenside lineations with frequent secondary elements, like Riedel shears, lunate fractures, grooves, displaced and distorted clasts, etc. Paleostress calculations were applied to fault-slip data using the method of Angelier (1984). Calculations from the main, long fault segments resulted in the three-fold stress field evolution, which was known from many localities of the Pannonian basin (Fodor et al. 1999). Not all faults bear the sign of all three events; only the most favourably oriented, NW-SE trending main faults have slickenlines belonging to three generation. It is to note that numerous faults have curved slickenlines suggesting that change of the stress field was quite continuous process and not an abrupt event. In the light of this field observation, the three stress fields may be regarded as clear end-members of a continuously changing brittle deformation; end-members defined by the stress calculations.

In addition to characterisation of the main faults, I tested the effect of connecting splays and secondary fractures. In most of the tested cases, the NW trending main, dip-slip or oblique-slip faults are connected to more northward trending pure normal faults. Calculations were carried out for the main segments, for the connected splays only, and for combined data of the whole fault zones. Results suggest that connecting fault splays are characterised by slightly different stress axes than of the main fault segments. Calculation for the combined data set, however, resulted in acceptable misfit angle for both the connecting and main faults. The resulting stress axes for the combined set differs only slightly form that one calculated for the main fault and can be considered as an ‘average’ stress field.

The results worn us about ‘automatic’ interpretation of stress field data in the following way: in the field we may measure only (or majority) secondary features, but not or only occasionally the main fault segments. Thus, the calculated stress axes derived from accidentally selected outcrops may not necessarily represent the general stress field but only local deviations. To avoid this pitfall, the understanding of the regionally representative fault pattern is necessary. On the other hand, the relatively small deviations obtained from different segments of a complex fault zone suggest minor “mistakes” in stress field determination, even if we failed to measure the most characteristic fault planes. In addition, evaluation of the stress field determination can take into account the scale of the research. In the first step of the structural investigations, when only the major outline of the stress field is outlined, minor deviations of the stress field may not represent important problem in interpretation. Structural geologists may be self-confident that a detailed (probably second) phase of paleostress study will reveal local stress perturbations, and the appropriate scale of research, complex structural approach can counterbalance the ‘negative’ and annoying effect of disturbing secondary faults in stress field determination. This was the case in the Pannonian basin, where the first, basically correct interpretation of scattered data (Bergerat 1989) was refined by later more detailed works (Fodor et al. 1999, Márton and Fodor 2003), which had the possibility to incorporate wider structural data sets.

1 References

Angelier, J. 1984: Tectonic analysis of fault slip data sets. – J. Geophysical Research 89, B7, 5835–5848.

Almási, I. and Fodor, L. 1995: Relay ramp structures and related stress field variations. – Terra Abstract suppl. No 1, Terra Nova, 7, p. 269, Blackwell, Oxford.

Bergerat, F. 1989: From pull-apart to the rifting process: the formation of the Pannonian Basin. – Tectonophysics 157, 271–280.

Fodor, L., Csontos, L., Bada, G., Györfi, I. and Benkovics, L. 1999: Tertiary tectonic evolution of the Pannonian basin system and neighbouring orogens: a new synthesis of paleostress data. in: Durand, B., Jolivet, L., Horváth, F. & Séranne, M. (eds): The Mediterranean Basins: Tertiary extension within the Alpine Orogen. – Geological Society, London, Special Publications, 156, 295-334, London.

Horváth, F. and Royden, L. 1981: Mechanism for the Formation of the Intra-Carpathian Basins: a Review. – Earth Evolution Sci. 3, 307– 316.

Márton, E. and Fodor, L. 2003: Tertiary paleomagnetic results and structural analysis from the Transdanubian Range (Hungary); sign for rotational disintegration of the Alcapa unit. – Tectonophysics, 363, 201–224.

Peacock, D. C.P. and Sanderson, D.J. 1994: Geometry and Development of Relay Ramps in Normal Fault System. – AAPG Bulletin, 78, 147–165.

Tari, G., Horváth, F. and Rumpler, J. 1992: Styles of extension in the Pannonian Basin. –Tectonophysics, 208, 203–219.